ST-ICD-91
Baseline Issue
July 29, 1994

HUBBLE SPACE TELESCOPE
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AXIAL SCIENTIFIC INSTRUMENT TO SPACE SUPPORT EQUIPMENT (SSE) INTERFACE CONTROL DOCUMENT

July 1994

Goddard Space Flight Center
Greenbelt, Maryland

Release Date: February 1, 2002

DOCUMENT CHANGE RECORD

Sheet: 1 of 1

TITLE: Axial Scientific Instrument to Space Support Equipment (SSE) Interface Control Document	REVISION: Baseline Issue
NUMBER: ST-ICD-91	DATE: July 29, 1994

CHANGE NO. DATE:	TO INCORPORATE THE CHANGE INTO THE DOCUMENT: ADD PAGES:	REMOVE PAGES:	CHANGE AUTHORIZATION INSTRUCTIONS, COMMENTS
Baseline Issue 7/29/94	Entire Document	Entire Document	CCR #3986R1 Level 3B CCB Minutes #442
IRN 001 11/3/95	Pages v, viii, 2-2, 3-13, 3-14, 3-15, 3-16, 3-19, 3-20, 3-20a, 3-20b, 3-22, 3-23, 3-28, and 3-29	Pages v, viii, 2-2, 3-13, 3-14, 3-15, 3-16, 3-19, 3-20, 3-22, 3-23, 3-28, and 3-29	CCR #4201 Level 3B CCB Minutes #467 HST CM RELEASE
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IRN 003 12/3/01	Page 3-23	Page 3-23	CCR #4899 (PIRN 004) Level 3B CCB Minutes #568 2/1/2 HST CM RELEASE

NOTE: After revising the document, file this sheet in document preceding table of contents.

HUBBLE SPACE TELESCOPE FLIGHT PROJECTS

Release Date: March 9, 2004 **DOCUMENT CHANGE RECORD** Sheet: 2

TITLE Axial Scientific Instrument to Space Support Equipment (SSE) Interface Control Document	REVISION: Baseline Issue
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ACRONYMS

ACS	Advanced Camera for Surveys	IRN 002
AS	Aft Shroud	
ASIPE	Axial Scientific Instrument Protective Enclosure	
CCB	Configuration Control Board	
CCR	Configuration Change Request	
COS	Cosmic Origins Spectrograph	IRN 004
CVCM	Collected Volatile Condensible Material	
ESD	Electrostatic Discharge	
EVA	Extravehicular Activity	
FGS	Fine Guidance Sensor	
FSIPE	FGS Scientific Instrument Protective Enclosure	
FSS	Flight Support System	
GFE	Government Furnished Equipment	
GSE	Ground Support Equipment	
GSFC	Goddard Space Flight Center	
HST	Hubble Space Telescope	
ICD	Interface Control Document	
LIS	Load Isolation System	
NASA	National Aeronautics and Space Administration	
NICMOS	Near Infrared Camera and Multi-Object Spectrometer	
NVR	Non-Volatile Residue	

ACRONYMS (Continued)

ORU	Orbital Replacement Unit
ORUC	Orbital Replacement Unit Carrier
OTA	Optical Telescope Assembly
PIRN	Preliminary Interface Revision Notice
SAC	Second Axial Carrier
SI	Scientific Instrument
SIPE	Scientific Instrument Protective Enclosure
SM	Servicing Mission
SM-2	Second Servicing Mission
SSE	Space Support Equipment
SSM	Support Systems Module
STIS	Space Telescope Imaging Spectrograph
STS	Space Transportation System
TBD	To Be Determined
TBR	To Be Resolved
TCS	Thermal Control System
TML	Total Mass Loss
TQCM	Temperature-controlled Quartz Crystal Microbalance
VCHS	Visibly Clean Highly Sensitive

TBDs and TBRs

	Page No.	Paragraph	Description
1	3-12	Table 3-3	Latch stiffnesses

1. SCOPE

1.1 PURPOSE

This Interface Control Document (ICD) defines and controls the detailed interface requirements of the Space Support Equipment (SSE) Axial Scientific Instrument Protective Enclosure (ASIPE) to the Axial Scientific Instrument (SI). This SSE shall include a Load Isolation System (LIS) and may include other SIPEs. This control is necessary to assure geometric and functional compatibility of these items for the successful performance of Hubble Space Telescope (HST) servicing missions.

1.2 ORGANIZATION

This ICD has been organized under the areas of Scope, Applicable Documents, and Requirements. The Requirements section is further subdivided into mechanical, structural, environmental, electrical, and astronaut interface areas between the ASIPE and the SI.

1.3 CONTENT STATUS

The data presented in this document represent current design definition in all cases except for those noted with a To Be Determined (TBD) or a To Be Resolved (TBR). "TBD" indicates the need for data which are currently not available, even in preliminary form. "TBR" indicates that the data supplied is the best information available but final details must be resolved by one or more interested parties.

1.4 ICD CHANGE PROCEDURE

Once this document is baselined, changes to this ICD, or removal of either a "TBD" or "TBR" must be done formally. This will require that a Preliminary Interface Revision Notice (PIRN) and its associated Configuration Change Request (CCR) be processed through a Goddard Space Flight Center (GSFC) Configuration Control Board (CCB) in accordance with SCM-1020B. A table of TBD/TBRs will be maintained at the front of this document until they all have been resolved.

2. APPLICABLE DOCUMENTS

The following documents, at the revision levels noted, form a part of this Interface Control Document to the extent specified. In the event of a conflict between any of the following referenced documents and this ICD, the following order of precedence shall be adhered to: 1. ST-ICD-02; 2. this document; 3. all other reference documents.

2.1 GOVERNMENT DOCUMENTS

Document	Name
ASTM E-595	Methods of Test, Total Mass and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
FED-STD 209D	Clean Room and Work Station Requirements, Controlled Environment
ICD-A-14009-SM	Shuttle Orbiter/HST SM2 Cargo Element Interfaces
MIL-STD-1246B	Product Cleanliness Levels and Contamination Control Program
NSTS 07700 Volume XIV Attachment 1	Shuttle Orbiter/Cargo Std. Interfaces
NSTS 07700 Volume XIV Appendix 7	System Description and Design Data Extravehicular Activities
SCM-1020B	HSTP-G Configuration Management Plan
ST-ICD-01F	SSM to OTA ICD

Document	Name
ST-ICD-02E	Axial SI to OTA and SSM ICD
ST-ICD-10F	ST to SSE
STR-29	HST SM Contamination Control Requirements

2.2 NON-GOVERNMENT DOCUMENTS

Document	Name
HDOS	
679-0218-023	Drawing, "A" Fitting (1/3 SI)
679-0219-023	Drawing, "A" Fitting (2/4 SI)
679-0393-034	Drawing, "B" Fitting (1/3 SI)
679-0392-034	Drawing, "B" Fitting (2/4 SI)
911-7140-001	Drawing, "B" Fitting (2/4 SI)
679-5832-013	Drawing, "C" Fitting
911-7113-001	Drawing, "C" Fitting
679-0057	Drawing, "A" Latch Interface
679-0374	Drawing, "C" Latch Interface
679-0945-007	Drawing, Guiderail/Microswitch
679-4807-005	Drawing, Guiderail/Microswitch
679-9954	Drawing
TE 679-4046	OTA/SI Latch Qualification Test
TE 679-4081	OTA/SI Latch Qualification Test
TE 679-4082	OTA/SI Latch Qualification Test

IRN 001

3. REQUIREMENTS

3.1 INTERFACE FUNCTIONS

The ASIPE is an enclosure which supports and protects an Axial SI during HST servicing missions utilizing the Space Transportation System (STS). A servicing mission will include taking a replacement SI up to orbit for installation in the HST and the return of either the replaced or replacement SI from orbit. This requires that the ASIPE conform to all required interfaces with the Axial SI.

3.1.1 SI Interface Functions

The SI being carried has interfaces with the interior of the SIPE. The SIPE, in conjunction with the rest of the SSE, will maintain the SI's environment within the required parameters as detailed in this document and ST-ICD-02. The SIPE will support the Axial SI at its three mounting points, "A," "B," & "C," utilizing a set of HST-type flight latches. The attachment at these three points is the same as that provided by the Optical Telescope Assembly (OTA) (see ST-ICD-02) and is statically determinate. The constraint directions are contained in Table 3-1.

It is important to note that Axial SIs and their latches have two configurations. They may fit in either axial bay positions 1 & 3 or positions 2 & 4 of the HST aft shroud. Mission flexibility, therefore, requires that it be possible to configure the SIPE for compatibility with either SI position. This requires the capability to mount latches for either a position 1 & 3 or a position 2 & 4 SI in the SIPE.

Table 3-1

Latch Constraint Directions

Latch Point	Constraint Directions
"A"	$\pm A_1$ $\pm A_2$ $\pm A_3$
"B"	$\pm A_2$ $\pm A_3$
"C"	±Perpendicular to the line connecting points "A" and "C"

Reference: Figure 3-2 for coordinate system definition.

In addition to ground integration/deintegration activities, it must be possible for astronauts during an Extra Vehicular Activity (EVA) to remove the replacement SI from the SIPE and install either the replacement or the replaced SI into the SIPE without causing any damage to the SI or the SIPE or creating any personnel hazards.

3.1.2 SSE Interface Functions

The Orbital Replacement Unit Carrier (ORUC) SIPE shall be capable of being flown alone or in conjunction with other SIs/SIPEs and Orbital Replacement Units (ORUs) in a variety of possible combinations depending on servicing mission requirements. Future mission flexibility requires that mechanically attached and therefore replaceable side beam structure be included to provide for adaptation to different mission configurations. The potential ORUC SIPE combinations which may be flown in support of HST are:

1. ASIPE alone.
2. Fine Guidance Sensor (FGS) SIPE (FSIPE) and ASIPE.

The Second Axial Carrier (SAC) SIPE shall be flown alone or in conjunction with other ORUs in a variety of combinations, depending on mission requirements.

The SIPE shall be mechanically and electrically connected to whatever SSE configuration is required for a particular servicing mission. Except for acoustics, the SIPE is not responsible for providing any load attenuation capability. The SSE shall be responsible for ensuring compliance with all of the load requirements of Section 3.4.1.

3.2 GENERAL INTERFACE CHARACTERISTICS

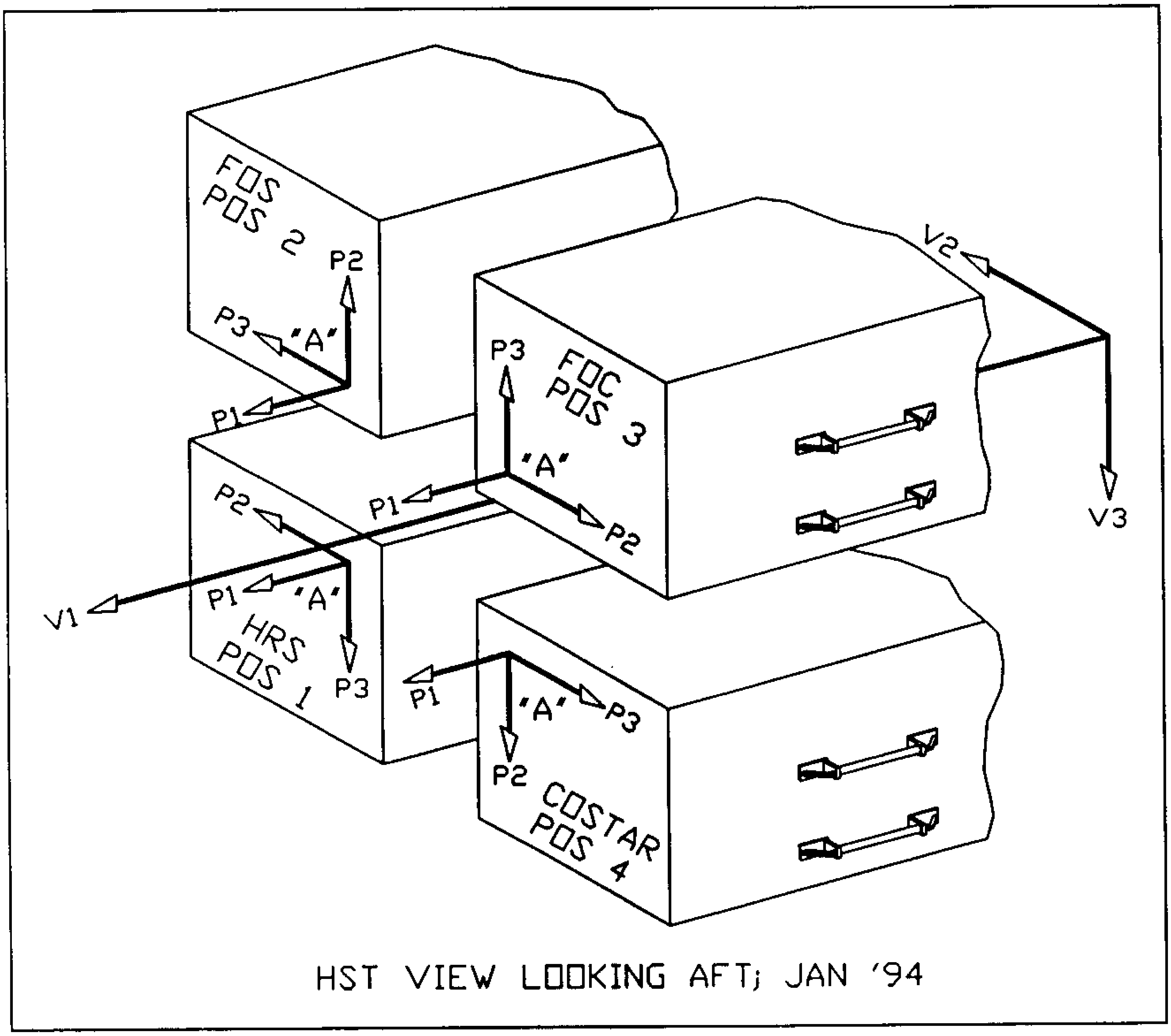
3.2.1 Interfaces

The SIPE has mechanical, structural, and environmental (loads, thermal, pressure, and contamination control) interfaces with the Axial SI. It also has electrical and structural interfaces with the SSE and possibly, depending on mission configuration, with another SIPE.

3.2.2 Coordinate Systems

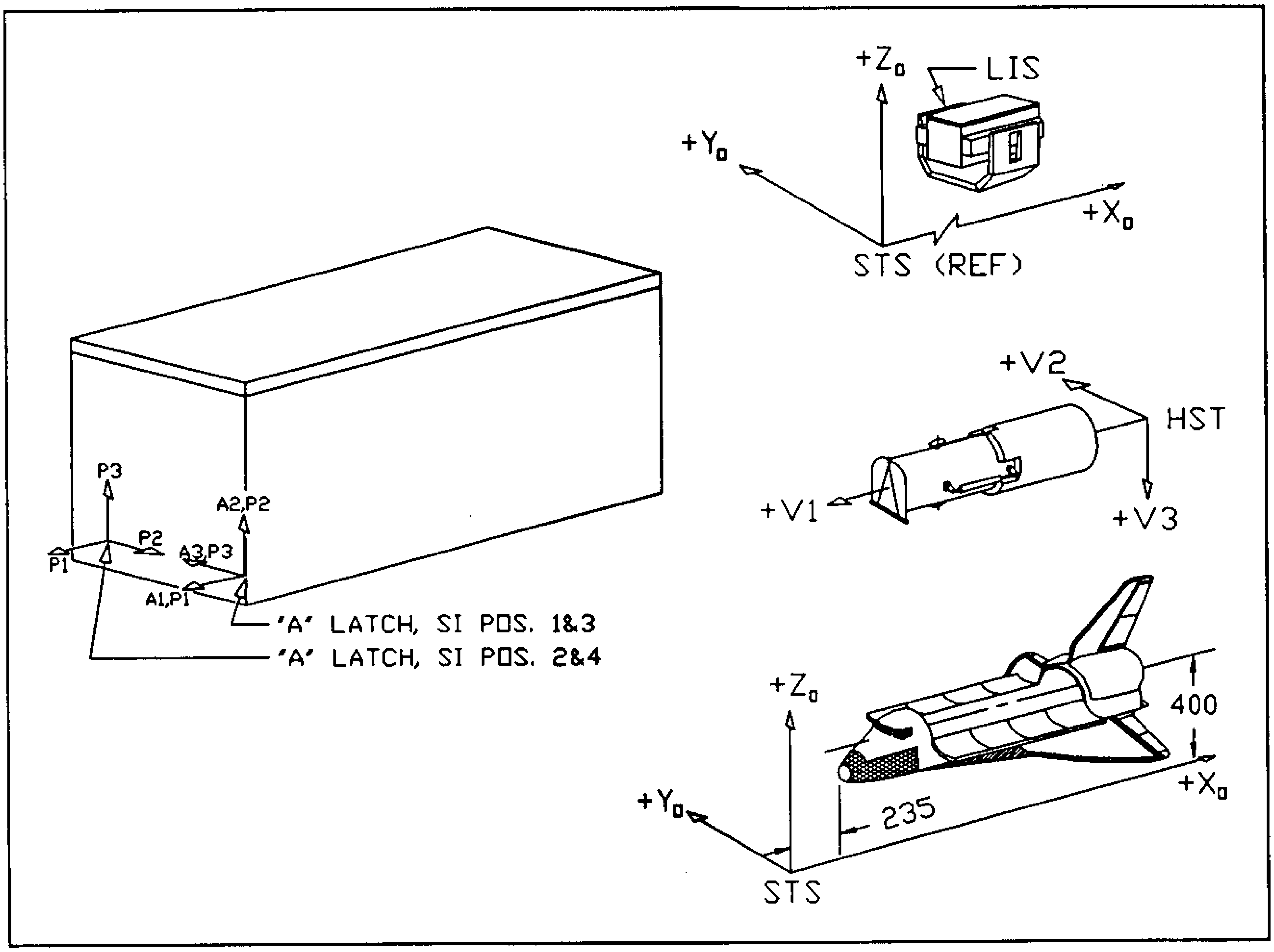
The Axial SI coordinate systems, (P_1, P_2, P_3), and the HST coordinate system, (V_1, V_2, V_3), are shown in Figure 3-1. Note that the SI position 1 and 3 coordinate system is unique with respect to the position 2 and 4 coordinate system. The STS coordinate system (X_0, Y_0, Z_0), which is also used for the ORUC, the FSS, and other SSE, is defined in NSTS 07700, Volume XIV, Attachment 1, (ICD 2-19001). These are illustrated in Figure 3-2.

3.2.2.1 ASIPE Coordinate System. The ASIPE coordinate system (A_1, A_2, A_3) is coincident with the SI position 1 and 3 coordinate system (P_1, P_2, P_3) when one is mounted in the ASIPE and their origin is at the "A" latch point. If a position 2 or 4 SI is flown, the "A" latch point and the SI's coordinate system will not be coincident with the ASIPE's. This is shown in Figures 3-2 and 3-3. When flown in the ORUC or the SAC, the ASIPE shall be positioned with its A_2 axis parallel to the orbiter Z_0 axis and its A_1 axis parallel to the orbiter X_0 axis as shown in Figure 3-2.



NOTE: The "A" latch points are at the P_1, P_2, P_3 coordinate origins and are offset ±6.400" as appropriate from the V_1 axis in both the V_2 and V_3 directions.

Figure 3-1. Axial SI Coordinate Systems



NOTE: The SIPE coordinate system (A_1, A_2, A_3) is coincident with the positions 1 & 3 SI coordinate system (P_1, P_2, P_3) but not with the positions 2 & 4 SI coordinate system (also P_1, P_2, P_3). The "A" latch will always be located at the SI coordinate system origin.

Figure 3-2. ASIPE versus STS and HST Coordinate Systems

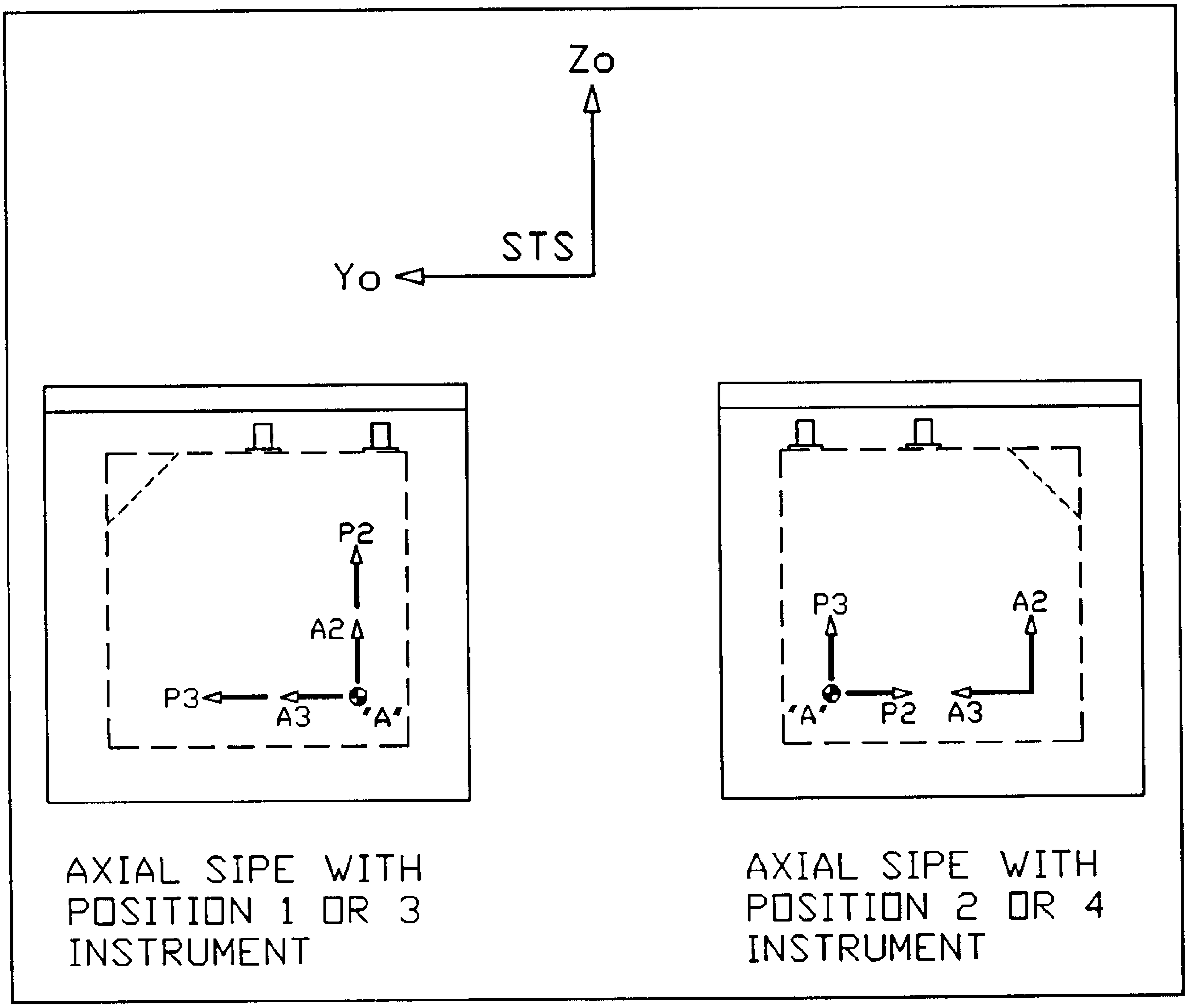


Figure 3-3. **ASIPE versus SI** Coordinate Systems

3.3 MECHANICAL INTERFACES

The mechanical interfaces described in this section include the ASIPE envelope, the Axial SI latch mounting interfaces, the SI to ASIPE guiderails, ground handling interfaces, electrical connectors, purge fittings, and venting.

Unless otherwise noted all dimensions are applicable at 21°C and are in inches with tolerances as follows:

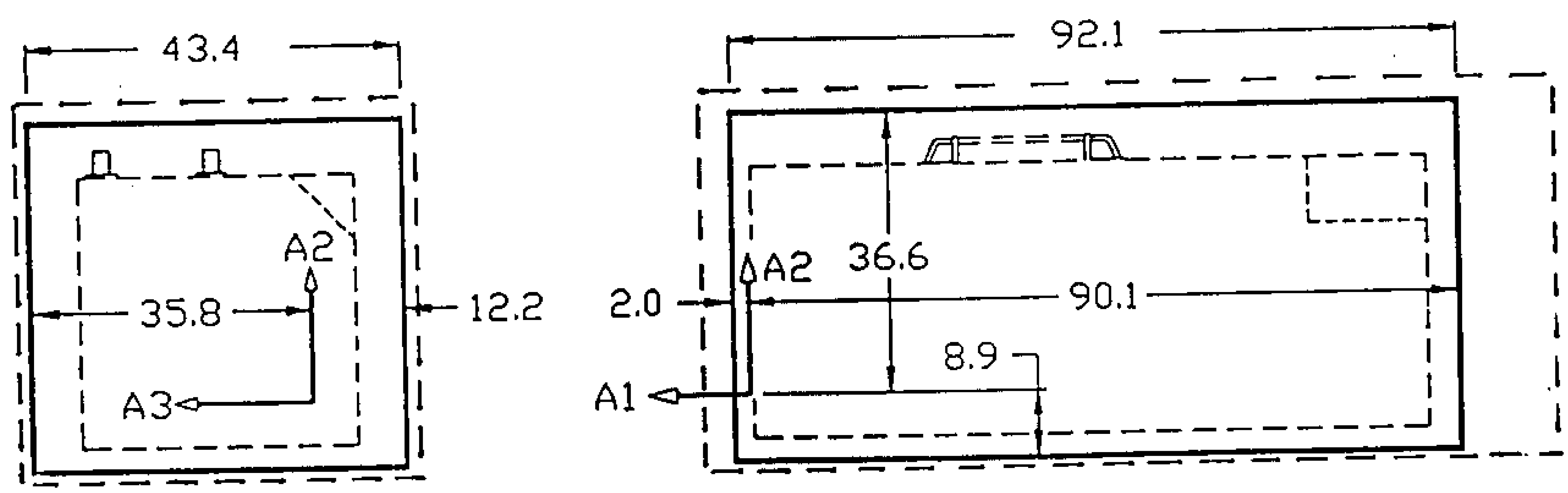
.xxx = ±0.005 in.		Angles = ±30 min.
.xx = ±0.01 in.		
.x = ±0.05 in.		

3.3.1 SIPE Envelopes

Figure 3-4 shows the static interior envelope of the SIPE. All SIPE hardware (except items which must reach the SI such as latches and purge fittings), including heaters, SIPE cabling, etc. must be physically located outside of this static envelope. Dynamic exterior and interior envelope clearances for the SIPE shall be verified by analysis. Axial SI static and dynamic envelopes are defined in ICD-02, Figures 3.3-1, 3.3-2, 4.3-1, and 4.3-2. There must be no dynamic contact between the SIPE and either the SI or any other flight hardware.

3.3.2 SI Mechanical Interfaces

The SIPE shall support the Axial SI at the three latch (interface) points, "A," "B," & "C". These point locations



NOTES: 1. Dimensions are minimum unless otherwise noted.
2. The interior envelope is the continuous line. Axial SI and SIPE exterior envelopes are shown as dashed lines for reference.
3. Reference: ST-ICD-02, Figure 3.3-1.

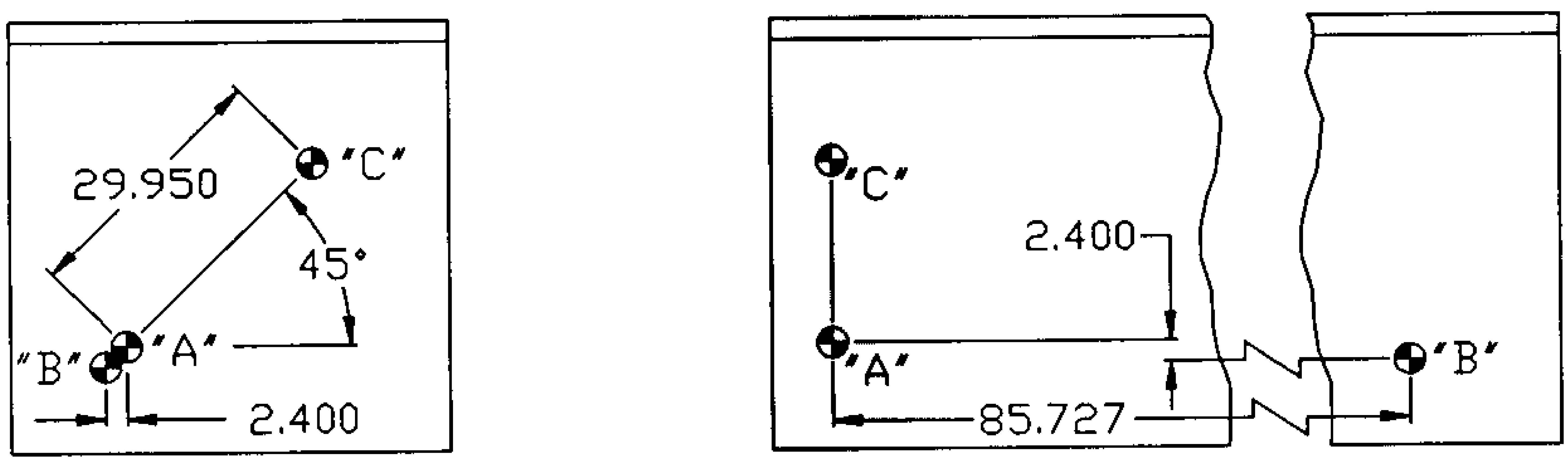
Figure 3-4. SIPE Static Interior Envelope relative to the "A" latch are shown in Figure 3-5. The locations of these latch points for the two possible instrument position configurations are defined in Table 3-2.

For informational purposes, the stiffnesses associated with each of the latches are shown in Table 3-3.

3.3.2.1 Latch Mount Points. The latch point geometry is shown in Figure 3-5. The SIPE/SI mount point fitting "A" is a ball-in-socket latch and is shown in Figure 3-6. The "A" latch is actively engaged and provides a drive screw on the SIPE half that engages a ball and socket. The SIPE half also includes microswitches for the "A" SEATED and the "A" LATCHED indicators. The latch at point "B" is an actively engaged rod in spherical bearing with a preload spring and is shown in Figures 3-7a and b. The "C" latch is a passive ball in flexure constraint as shown in Figure 3-8.

The SIPE half of all latches including actuating/locking mechanisms will be GFE. This will include the interconnecting drive shafts.

3.3.2.2 Guiderail Interface. The Axial SI has guide blocks attached to it. Guiderails with interface dimensions matching appropriate portions of the OTA and Support Systems Module (SSM) rails shall be installed on the SIPE to guide the SI during its installation and removal. Figures 3-9a and b show the critical SIPE guiderail locations and dimensions. The rail nearest the "A" and "C" latches includes a microswitch for the "B" READY indicators. The guiderail shall be clearly marked with a line or



NOTES:

1. Latch locations for carrying a position 2/4 SI shown. For a position 1/3 SI the latches are symmetrically opposite.
2. The 85.727 dimension applies only when the SI is inserted in the SIPE and fully latched.
3. All dimensions are basic.

Figure 3-5. SI to SIPE Latch Interface Points

Table 3-2

Latch Coordinates

SI POSITION	LATCH	A_1	A_2	A_3
1 and 3	"A"	0	0	0
1 and 3	"B"	-85.727	-2.400	-2.400
1 and 3	"C"	0	+21.177	+21.177
2 and 4	"A"	0	0	+23.600
2 and 4	"B"	-85.727	-2.400	+26.000
2 and 4	"C"	0	+21.177	+2.423

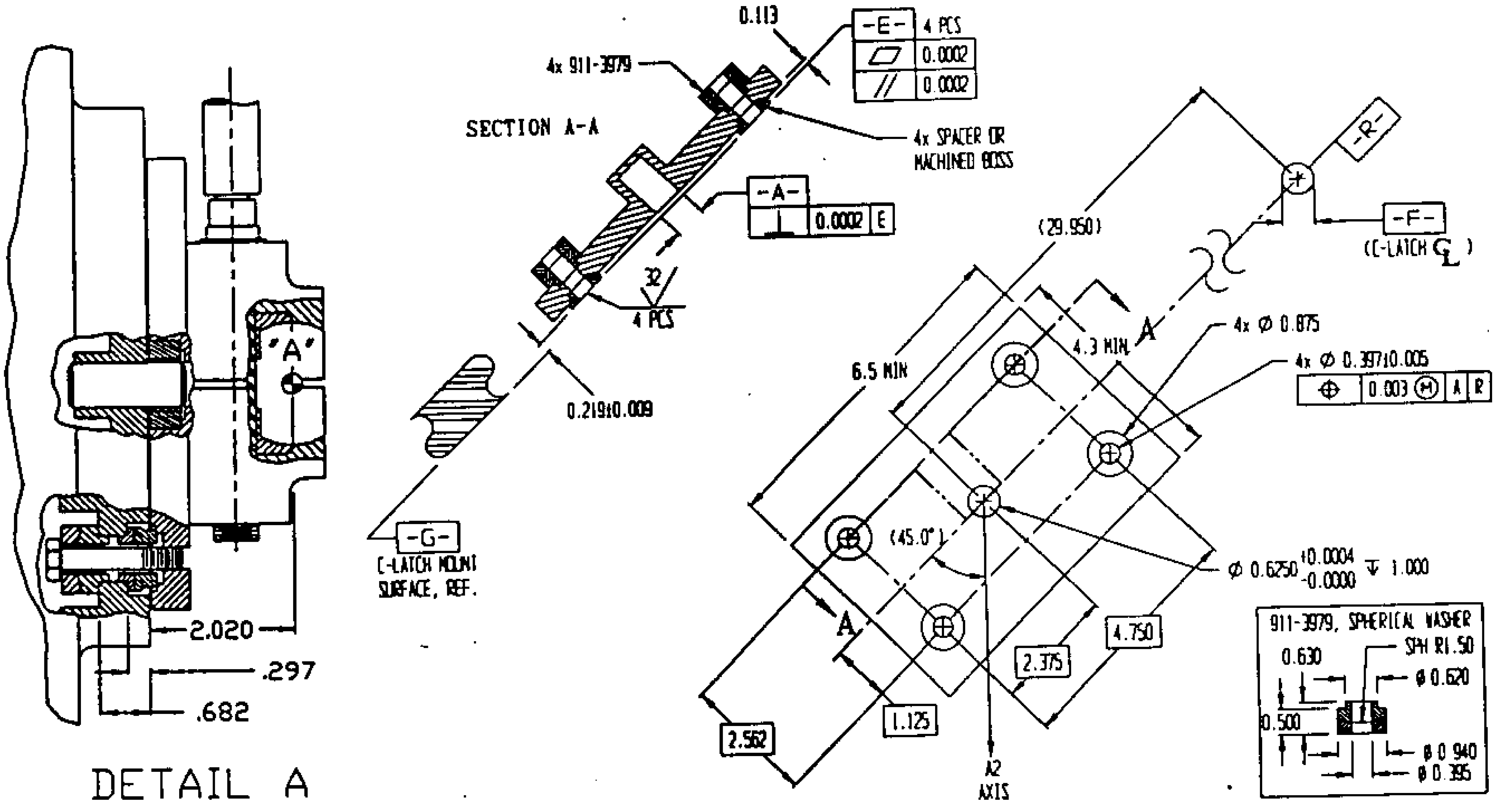
Table 3-3

Latch Stiffnesses (TBR)

	Avg. Stiffness, 1000 Lb./In.			
Latch	A_1 Dir.	A_2 Dir.	A_3 Dir.	Notes
"A" Tens./Comp.	245.0	223.0	117.0	1
"B" Tens./Comp.	—	82.0	125.0	2,3
"C" Fitting	158.0	Perpendicular to line between "A" and "C" latches.		1
Flexure	8.0			1

Notes:

1. HDOS "Axial Latch Design and Manufacturing" presentation and HDOS "HST Dynamic Math Model Review."
2. SAI "Revised B Mount Stiffnesses for the Proposed B Latch Flexure Redesign."
3. Latch and drive location may be rotated 90° for SAC. This will result in a rotation of the B latch stiffnesses.



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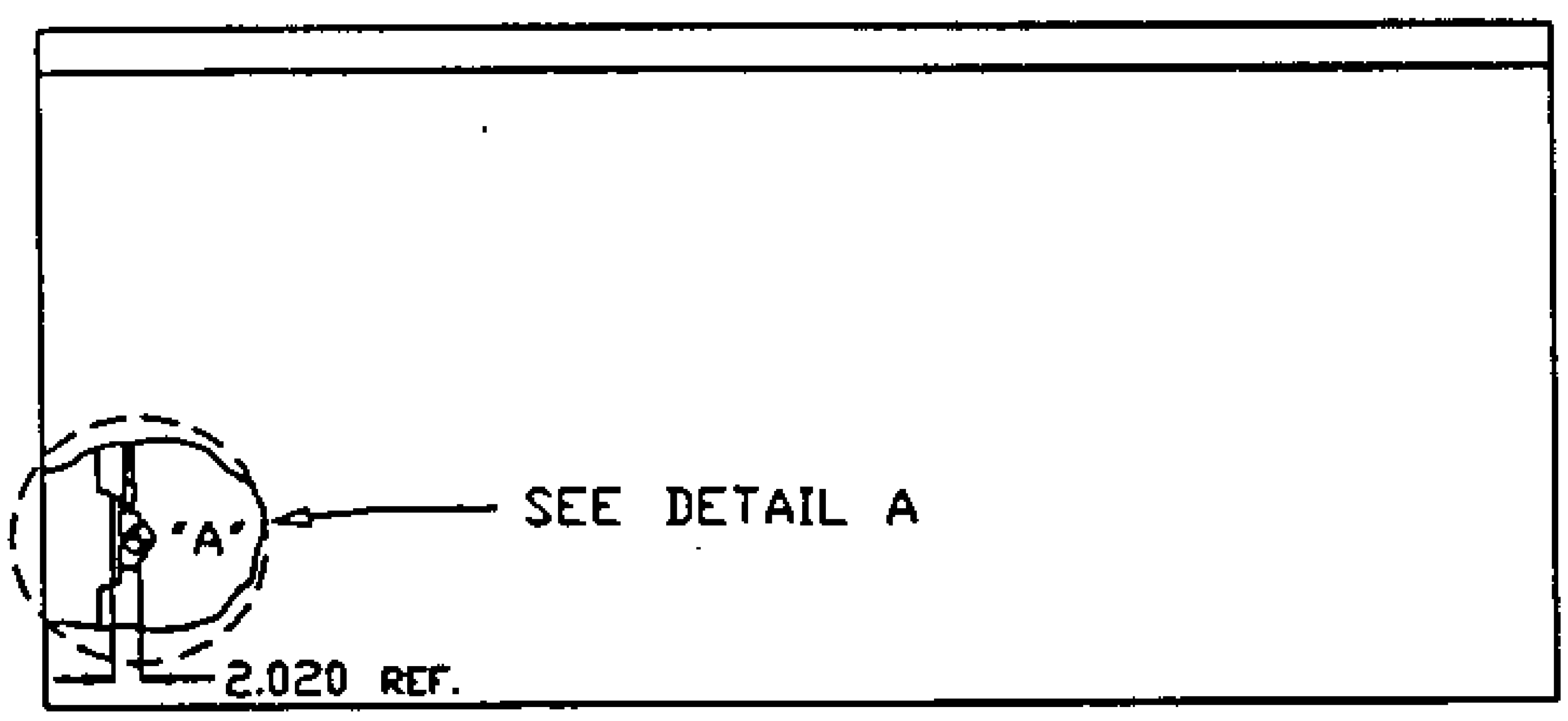
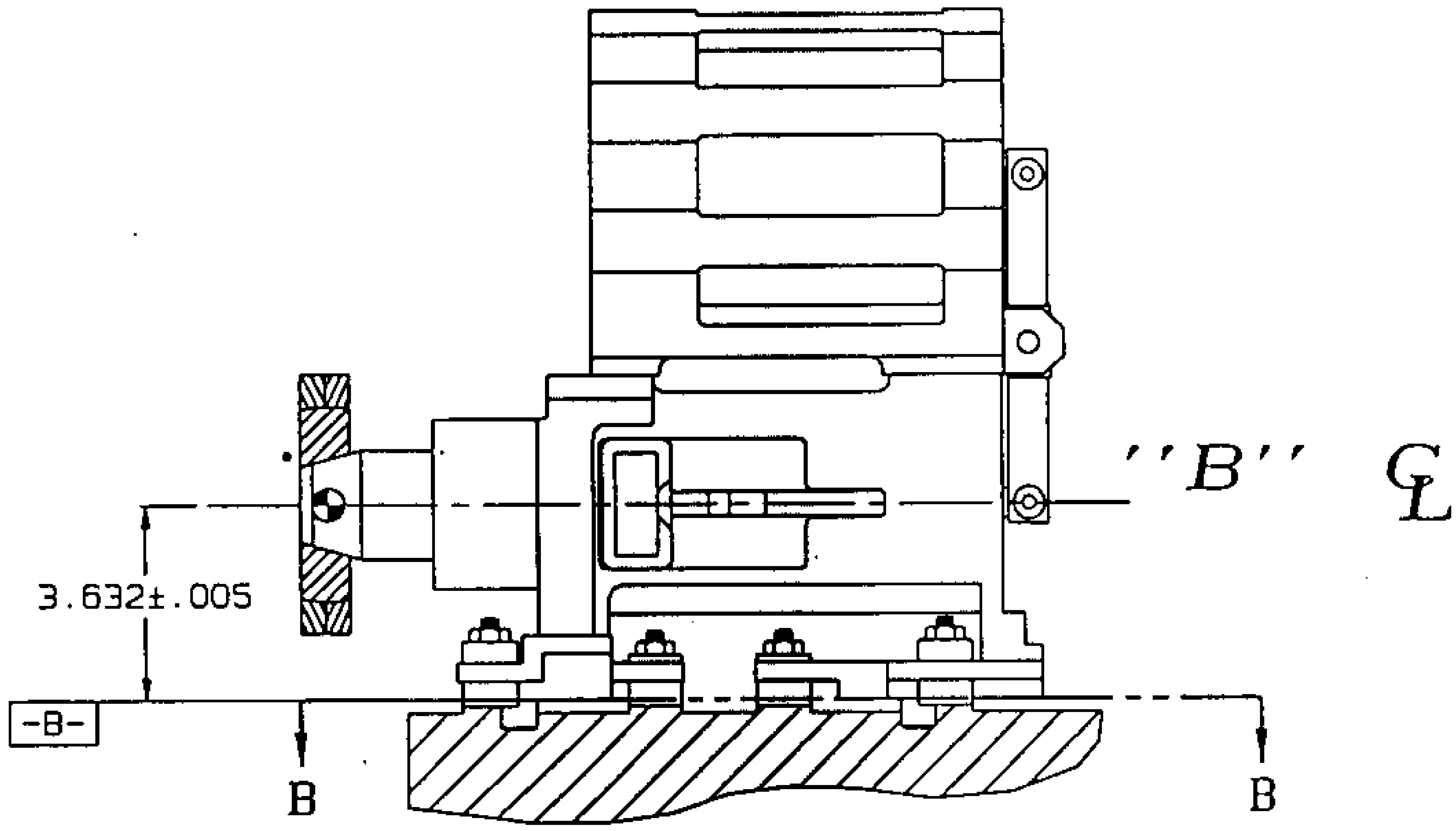


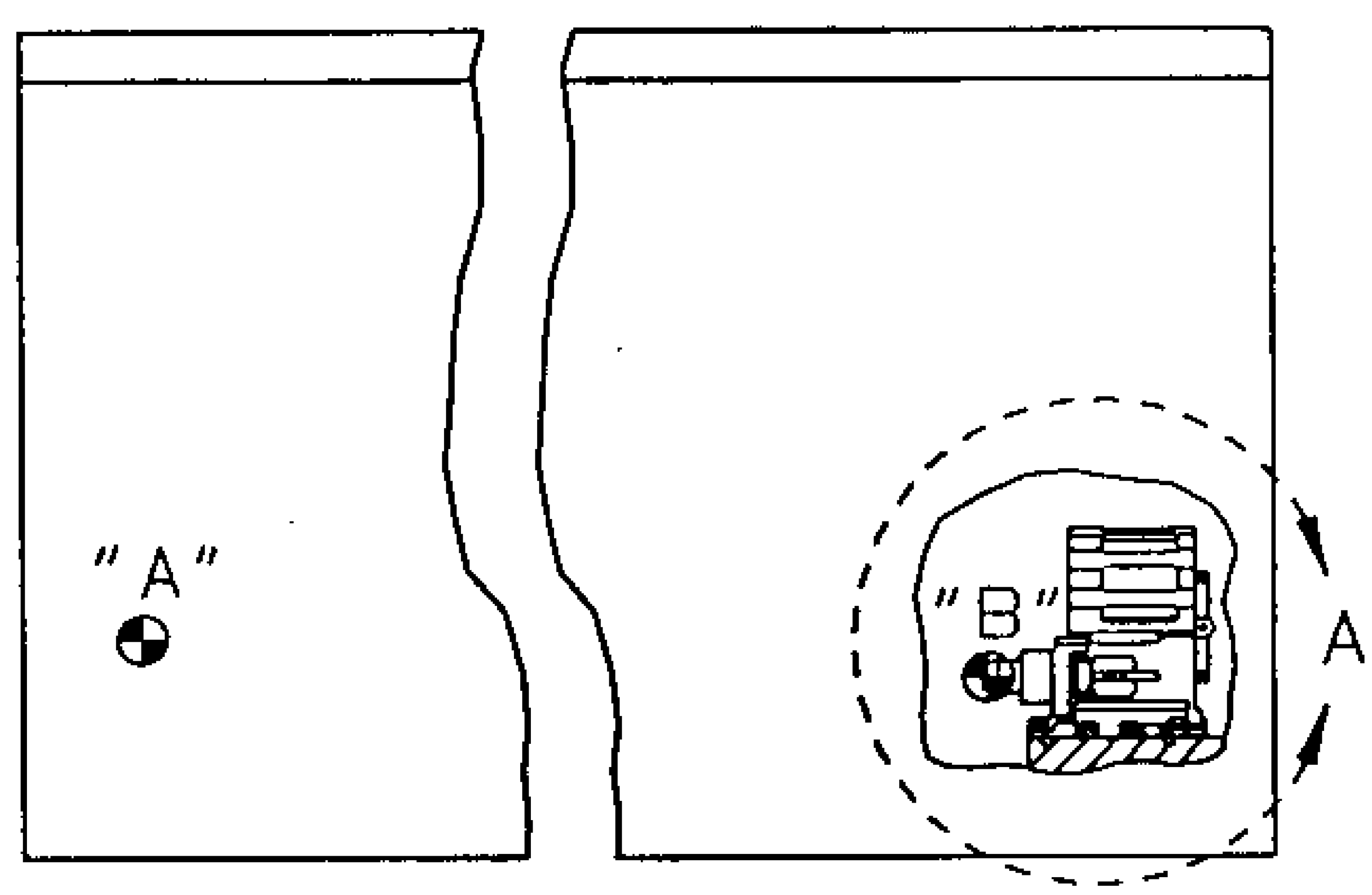
NOTE: LATCH NOT SHOWN FOR CLARITY

NOTES:
1. SI position 2/4 latch shown.
2. Use HDOS Dwg. 679-0057 for interface hole pattern definition.
3. Reference HDOS Dwg. 679-0218/19 for latch configurations.
4. Matched spherical washer set, HDOS 911-3979-003, required under 4 bolt heads.

Figure 3-6. "A" Latch Interface, SIPE Side



DETAIL A



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NOTES:

1. Adjust or shim as required to obtain dimensions shown in Figure 3-5.
2. HST position 1/3 latch is shown in location for a position 2/4 SI.
3. Ref. HDOS Dwg. 911-7140 and 679-0392/93 for latch configuration.
4. Latch and drive location may be rotated 90° for the SAC. This will result in a rotation of the B latch stiffnesses and allowables in Table 3-3 and Table 3-4.

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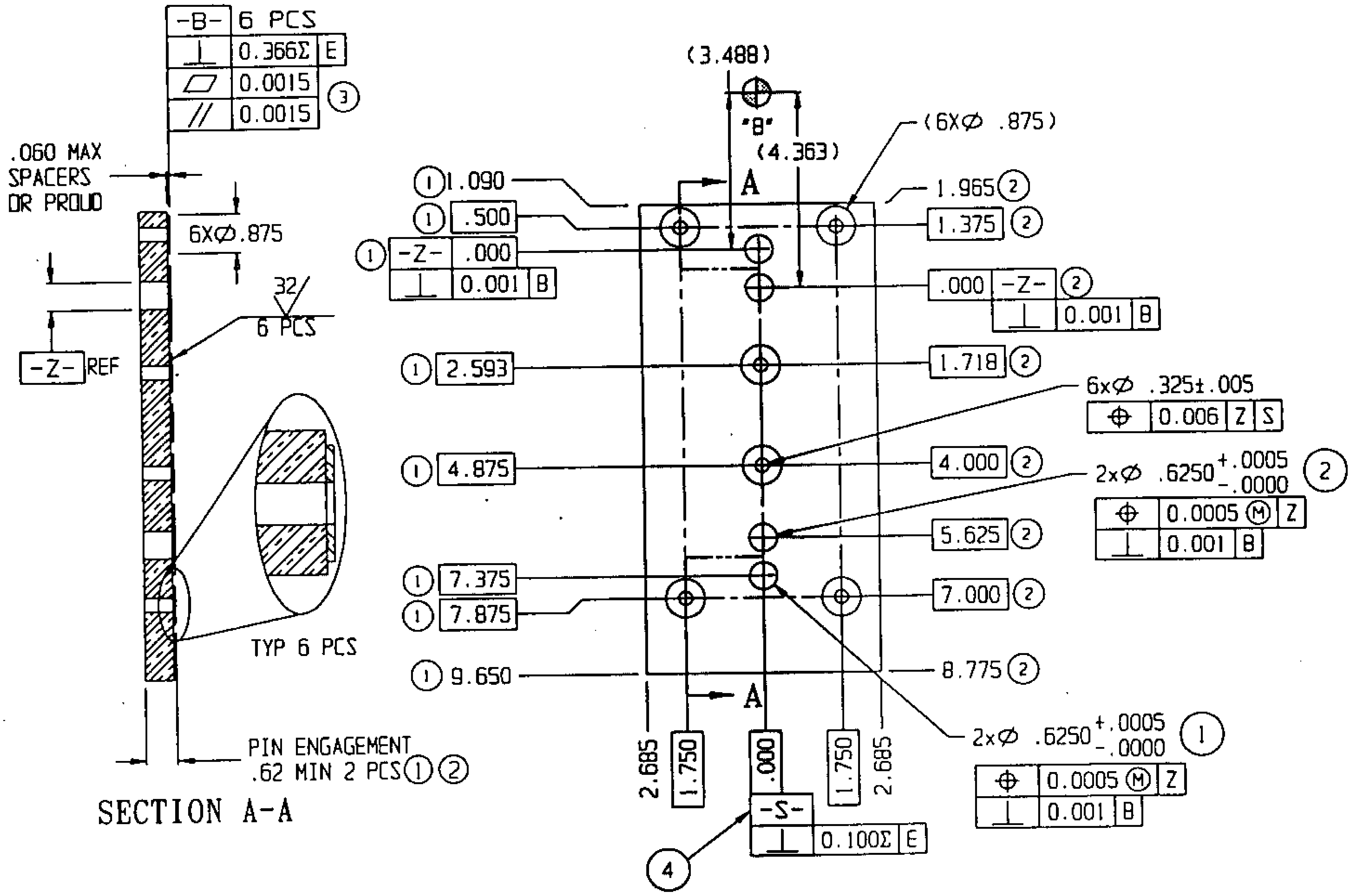
Figure 3-7a. "B" Latch Interface, SIPE Side



① : Locations for SI pos. 1 & 3 "B" Latch shear pins (679-0393)
② : Locations for SI pos. 2 & 4 "B" Latch shear pins (679-0392)
③ :Flatness and parallelisn for "Mykroyless" latch.
Latches with Mykroy require 0.001 flatness and parallelisn.
④ :Datum -S- refers to line forned by two shear pin hole Centers.

Section B-B (rotated 90°)

Figure 3-7b. "B" Latch Interface, SIPE Side

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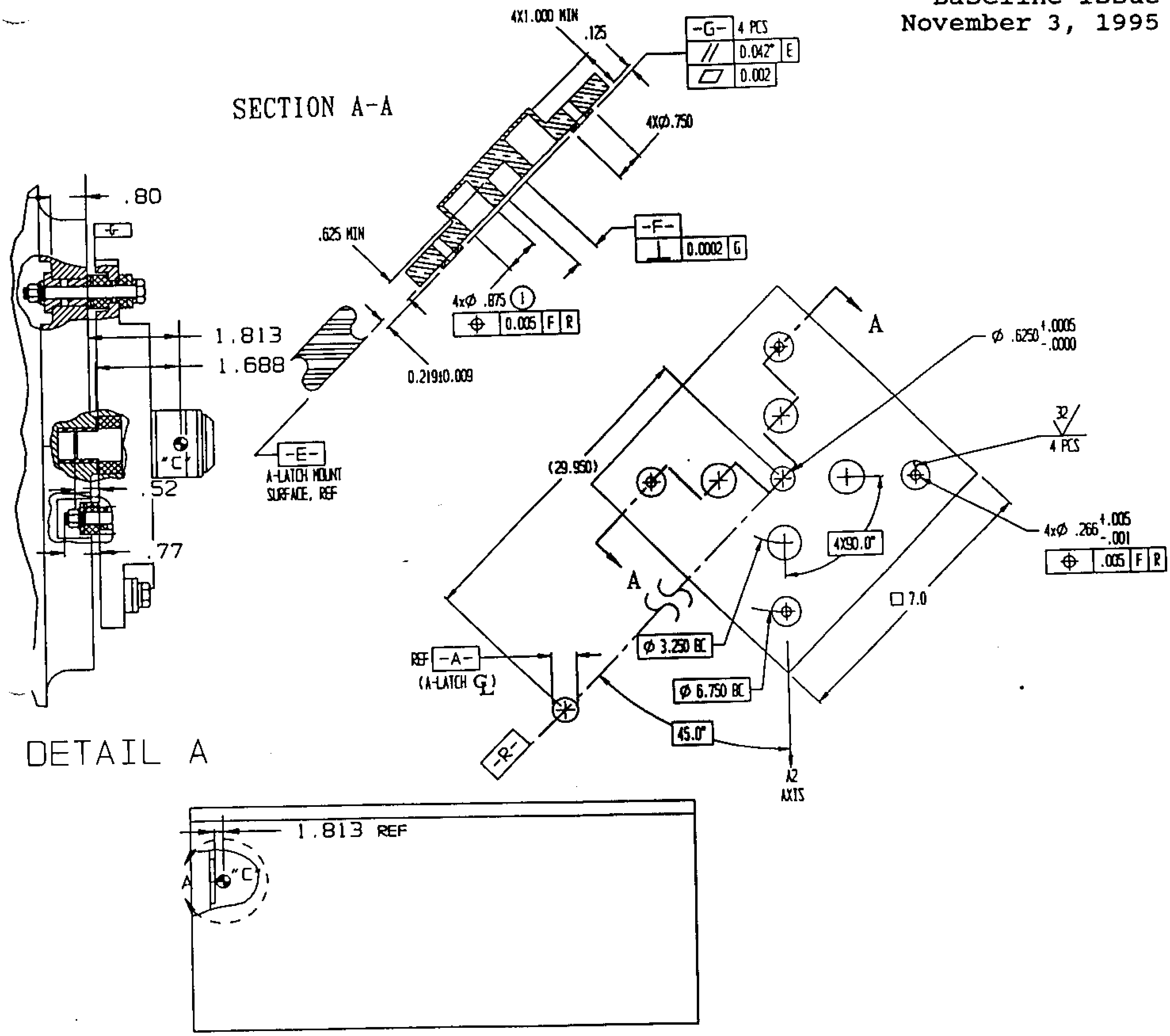

NOTES:

1. Four counterbores required for Mykroy equipped latch only.
2. Flatness and parallelism for "Mykroyless" latch. Mykroy equipped latch requires 0.001 flatness and parallelism.
3. Ref: HDOS Dwgs. 679-5832 and 911-7113 for latch configurations.

Figure 3-8. "C" Latch Interface, SIPE Side

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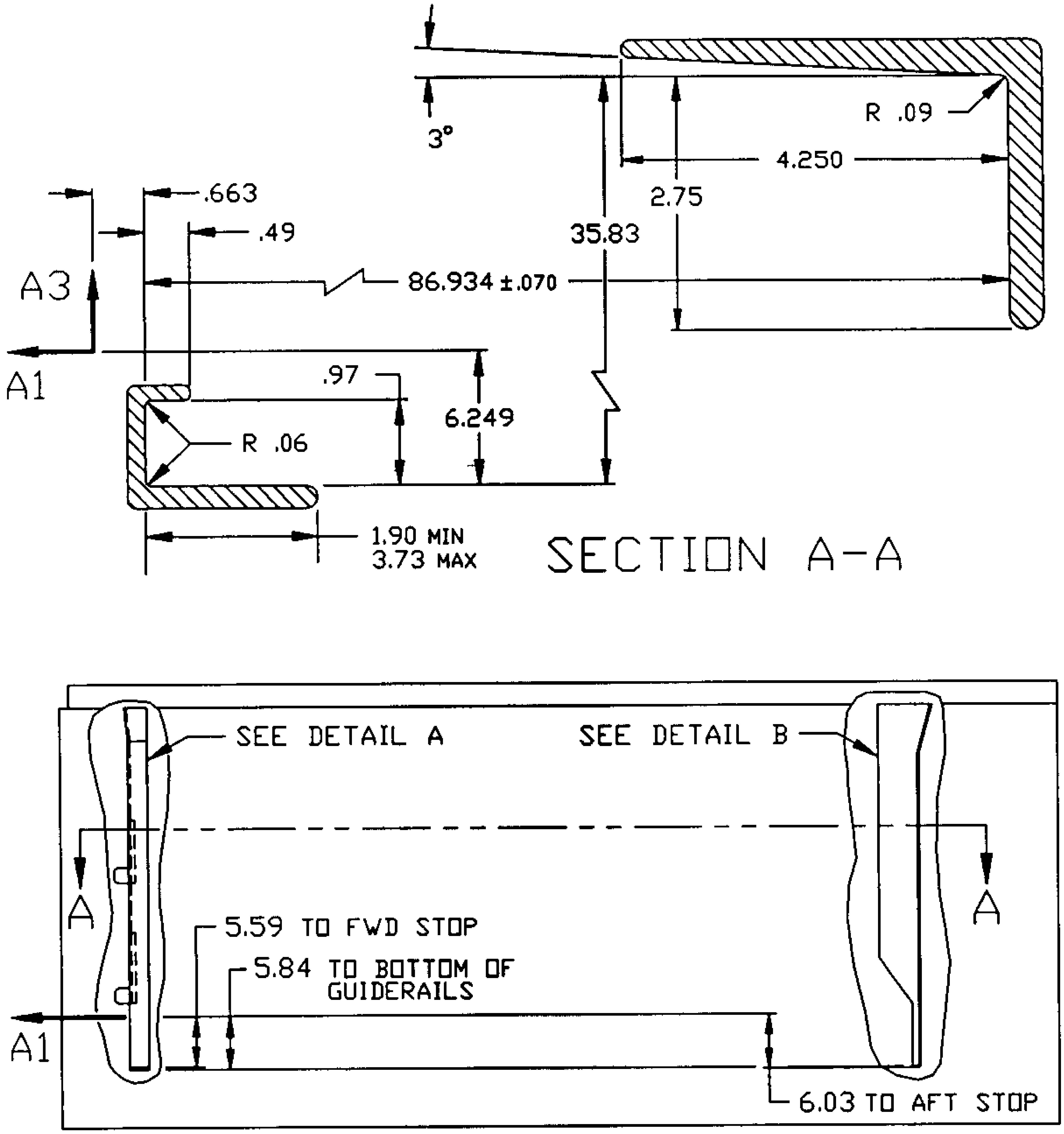
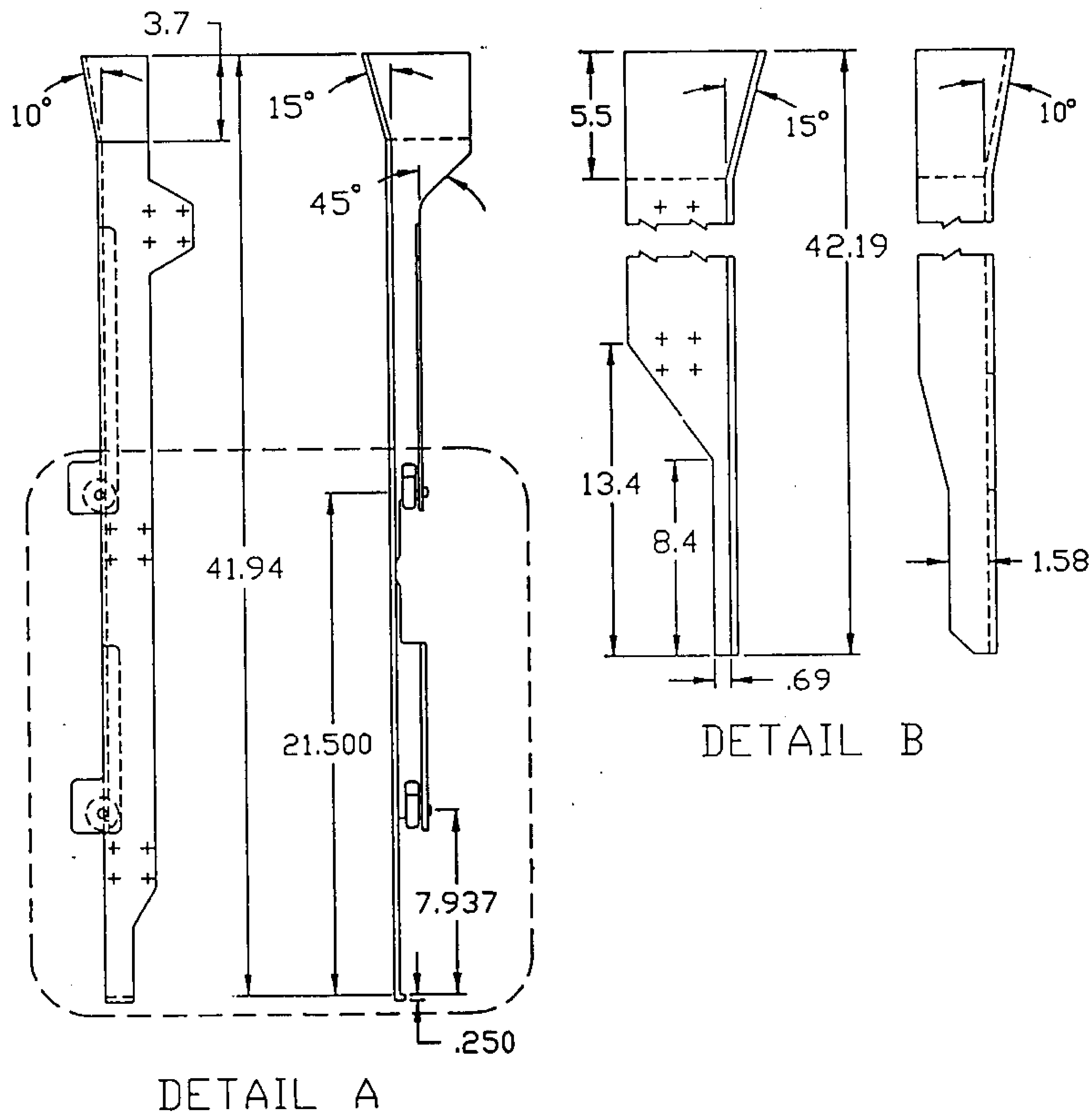


NOTES:
1. SI position 2/4 guiderails shown.
2. Ref. HDOS Dwg. 679-0945-007 and 679-4807-005 and ST-ICD-01F, Figure 3.3.11-4A and B.

Figure 3-9a. SI To SIPE Installation Guiderail Interface



NOTE: For details of microswitch location/adjustment in Detail A see HDOS drawings 679-0945-007 and 679-4807-005.

Figure 3-9b. SI to SIPE Installation Guiderail Interface lines to show the proper position of the SI when it is fully inserted prior to latch engagement. The guiderails shall not make either static or dynamic contact with the SI when the latches are engaged.

3.3.2.3 Interface Alignments. The SIPE mounted latches and guide rails will interface directly with flight instruments. Alignment of the latches with respect to the guide rails is critical to insure that the Axial SI can be installed/removed from the ASIPE without damage and that the SI is held clear of the rails during launch and landing. The alignments shall be verified using the HDOS Axial SI Simulator, part number 679-9954. Figure 3-10 and Table 3-11 define the alignment requirements. IRN 001

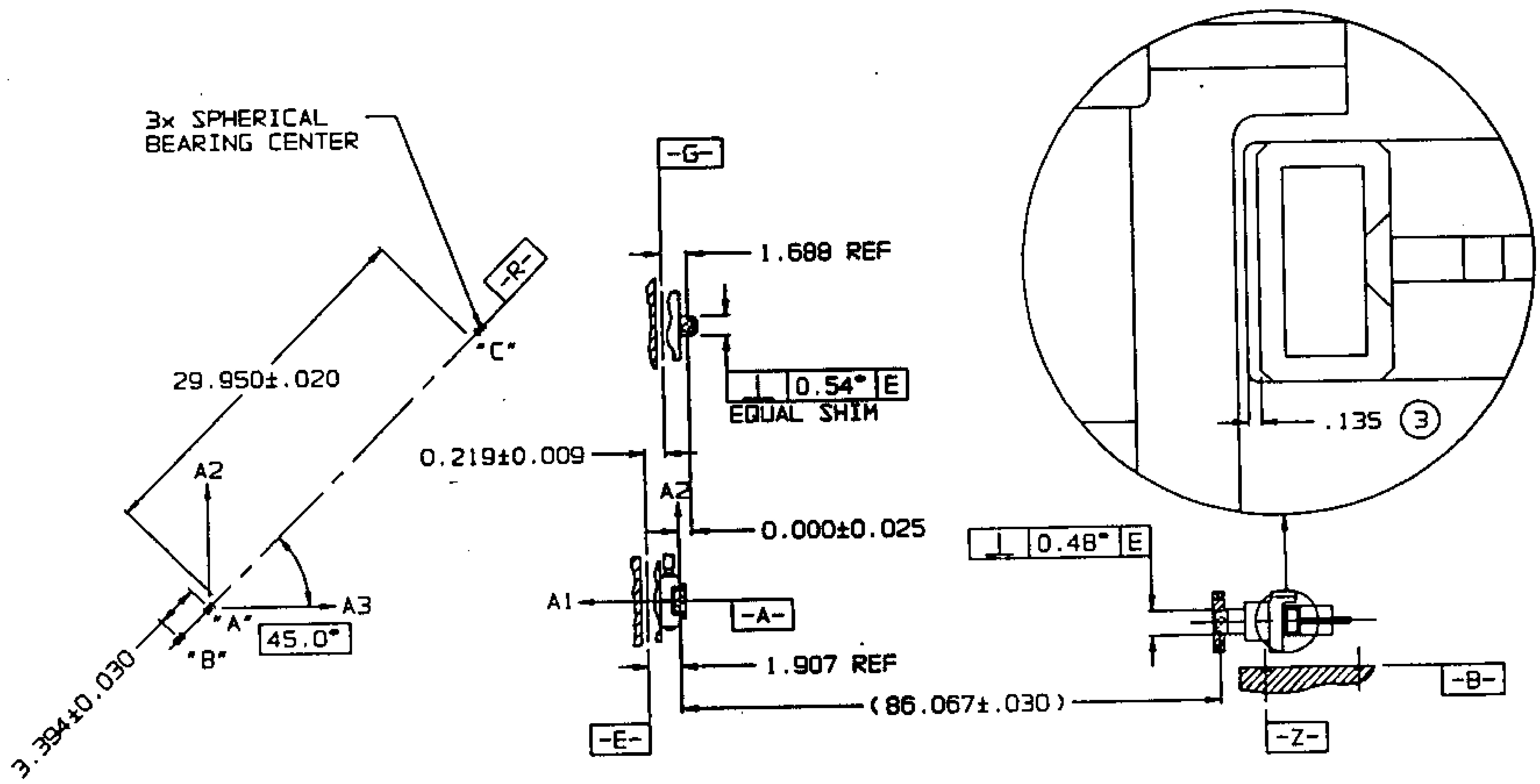
3.3.3 Ground Handling Interfaces

It shall be possible to open and close the lid in both horizontal and vertical configurations. The ground support equipment (GSE) and its SIPE interfaces shall provide for horizontal ground handling and transportation of the following configurations:

1. ASIPE alone.
2. ASIPE during SI fit checks/installation.
3. For the ORUC ASIPE combined with an FSIPE during SI integration/deintegration and with neither, either, or both SIs installed in their respective SIPEs.

3.3.4 SI Removal and Installation on Orbit

The SIPE must be compatible with the replacement and the replaced Axial SIs. The SIPE shall be designed so that an EVA crewmember can unlatch and open the doors of the SIPE using the door IRN 001



Notes:

1. A-coordinate system defined at the center of the "A" spherical bearing (both ASIPE and SI halves).
2. Latch locations for carrying a 2/4 SI shown. For a position 1/3 SI, the latches are symmetrically opposite.
3. The 86.067 dimension applies when the SI is inserted in the ASIPE with a 0.135 gap between the "B" latch track and housing. This gap is .152±.030 with the Axial Scientific Instrument Simulator (ASIS).
4. Data -E-, -B-, and -G- are physical latch seating surfaces. Data -A-, -F-, and -Z- are shear pin holes.

Figure 3-10a. ASIPE Latch Alignment Requirements

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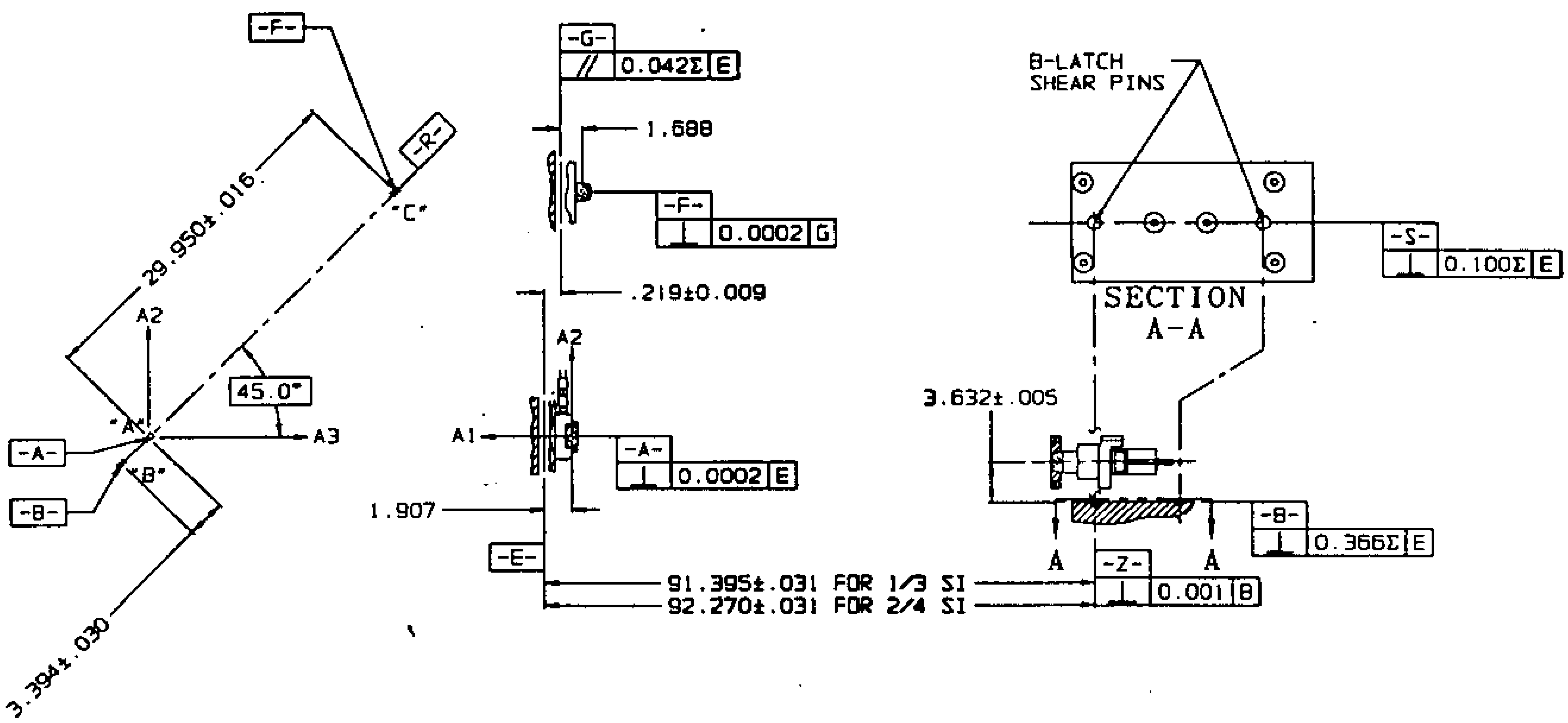

Notes:
1. A-coordinate system defined at the center of the "A" spherical bearing (both ASIPE and SI halves).
2. Latch locations for carrying a 2/4 SI shown. For a position 1/3 SI, the latches are symmetrically opposite.

Figure 3-10b. ASIPE Latch Alignment Requirements

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Table 3-11

Latch Static and Dynamic Tolerances

Latch Alignment Requirement	Static Alignment Tolerance	Dynamic Excursion Tolerance	Reserve
"B" Latch Plunger O.D Perpendicularity to "A" Latch Mount Interface (Datum E) in A_2 Direction.	±0.480°	±1.041°	±0.169°
"B" Latch Plunger O.D Perpendicularity to "A" Latch Mount Interface (Datum E) in A_3 Direction.	±0.480°	±1.041°	±0.169°
"C" Latch Clamshells O.D. Perpendicularity to "A" Latch Mount Interface (Datum E).	±0.540°	±2.034°	±0.286°
Pts. "A" to "C" Dimension of 29.950 at 45.0° to A_2 and A_3 Axes.	±0.020°	±0.152°	±0.019°
Pts. "A" to "C" Dimension of 0.000 in Despace (A_1).	±0.025°	±0.038°	±0.007°

IRN 001

latches. Operation of the SIPE SI latches shall be similar to operation of the HST aft shroud SI latches. The astronaut can then extract the replacement SI using its handrails and/or the Axial SI handle provided. The SI being replaced will have been removed from the HST and parked. The EVA crew members will install the replacement SI into the HST, and then will install the SI to be returned into the SIPE. There will be no provision for parking an SI or stowing any associated tools on or in the SIPE.

The design of all EVA interfaces shall meet the requirements of STE-43.

3.3.5 SI Accessibility

After installation of the Axial SI into the ASIPE, there will be access only to the top and 45° chamfer surfaces of the SI, provided that the main SIPE door is open. The rest of the SI must be considered inaccessible.

3.3.6 Electrical Connector Location

All electrical connectors and associated brackets or openings for both the SIPE and SI checks shall be located at the aft end of the SIPE.

3.3.7 Venting and Leakage

A vent with a removable/replaceable filter shall be located on the aft end to preclude damage to any part of the SIPE or its SI due to differential pressure during launch and return and to minimize the possibility of instrument contamination. The filter shall prevent passage of particles greater than 30 μm. The effective filtered vent area shall be sufficient to limit the maximum differential pressure seen by the SIPE during liftoff and landing events to 0.10 psi.

Leakage at the various joints of the SIPE is important from a contamination standpoint. The intent shall be to have no leakage in its outer skin or between the SIPE body and any removable doors or panels which will compromise compliance with the contamination requirements of this document.

3.3.8 Purge

Routing of the purge gas directly to the SIPE interior and/or instrument is to be accomplished via a purge line to an internal purge fitting which interfaces with the SI's forward bulkhead aperture snout as shown in Figure 3-11. During removal of the SI from the SIPE, this purge fitting remains with the SIPE. The purge fitting interface shall accomodate SI/SIPE misalignment and minimize interface forces to the SI. The fitting shall not impede on-orbit installation of the returning SI. IRN 001

The quality and composition of the purge gas shall not pose any safety hazard to the surrounding area or personnel and shall satisfy the requirements of the SI. The composition and flow rate of the gas supplied by the STS contractor will be determined by the SI contractor. The purge gas shall be either dry manufactured air or nitrogen for an empty SIPE. The SI purge gas should be dry nitrogen

IRN 001/ 003

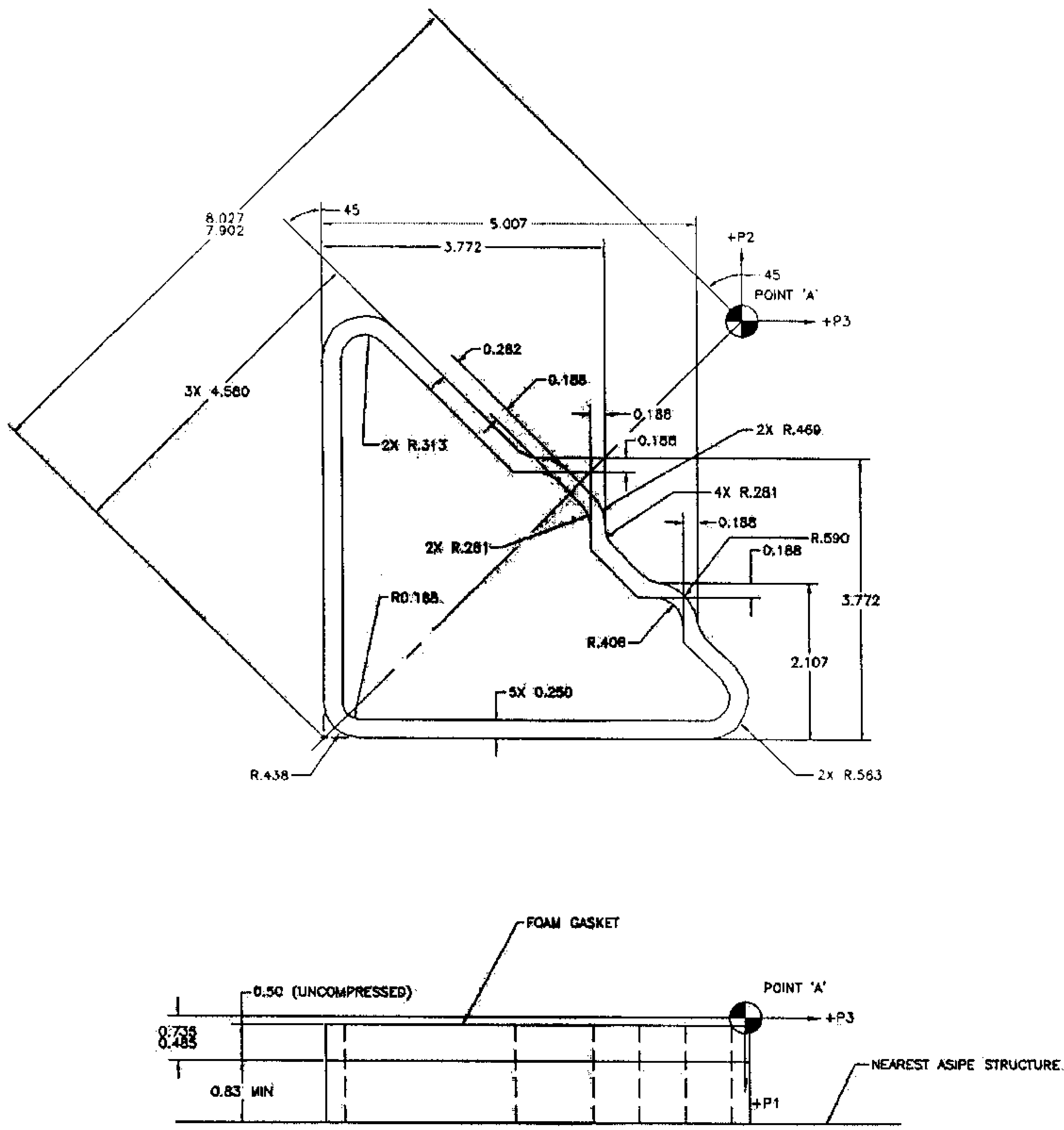


Figure 3-11. SIPE/SI Purge Fitting

3.3.9 Cryogen

Sub-cooling of a cryogenic SI through the SAC SIPE door opening shall be possible with the SI installed provided that all required areas of the dewar are accessible with the SIPE door open. An additional access door for cool-down of the cryogen shall be provided in the main door.

3.4 STRUCTURAL INTERFACES

3.4.1 Loads

The SIPE/SSE system shall be responsible for ensuring that latch and instrument limit loads and acoustic limits are not exceeded.

3.4.1.1 Latch Limit Loads. The latch limit loads shown in Table 3-4 are for reference only. Qualification of the original OTA/SI latches was accomplished utilizing a 1.25 test factor applied to limit loads. The limit loads include the "B" latch preload on the SI of 800 lbs +50/-0 lbs applied between latches "A" and "B" at 20°C. SM-2 latch limit loads shall be verified by stress analysis and test as required.

3.4.1.2 SI Limit Loads. The maximum allowable limit loads at the SI center of gravity shall be as specified in ST-ICD-02, paragraph 4.5.1.4.

3.4.1.3 Random Vibration Levels. The maximum allowable random level transmitted to the SI shall be as specified in ST-ICD-02, paragraph 4.5.1.6.

Table 3-4

Latch Limit Loads (Lb)

Latch	A_1 Dir.	A_2 Dir.	A_3 Dir.
"A"	+4197 -2231	±2278	±2407
"B"	Preload	±2540	±1370
"C"	±2650	Perpendicular to line between "A" and "C" latches.	

NOTES:

1. Valid for Latch orientations as shown in Figures 3-6 through 3-8.
2. References: HDOS Documents TE 679-4046, TE 679-4081, TE 679-4082.
3. Latch and drive location may be rotated 90° for SAC. This will result in a rotation of the B latch allowables.

3.4.1.4 Acoustic Loads. The maximum allowable acoustic levels transmitted to the SI shall be as shown in ST-ICD-02, Paragraph 4.5.1.7.

3.4.1.5 EVA Loads. For general on-orbit servicing operations, the following EVA loads and conditions apply.

3.4.1.5.1 Guiderail Loads. During SI on-orbit changeout, the guiderails attached to the SIPE may be subjected to an inadvertent crew member imposed limit load of 100 lbs in accordance with ST-ICD-02, Paragraph 4.5.1.8.2.

3.4.1.5.2 Latching Loads. During SI removal and installation in the SIPE, the "A" and "B" latch actuator rods will be locked and unlocked by an EVA crew member using standard EVA tools. The maximum load conditions for the actuator rod and other hardware are given in ST-ICD-01, Paragraph 3.5.7.1.

3.4.2 Mass Properties

The weight of GFE hardware items for the SIPE are defined in Table 3-5.

The axial SI mass property requirements are defined in ST-ICD-02, Paragraph 4.5.3. The mass properties of the Cosmic Origins Spectrograph (COS) shown in Table 3-6 are allowables, not final, and shall be updated by the instrument manager. Table 3-6 is informational only and subject to updating. IRN 002, 004

Table 3-5

GFE Hardware

ITEM	WEIGHT, Lbs.
Mount Point "A", SIPE Side	5.2
Mount Point "B", SIPE Side	30.2
Mount Point "C", SIPE Side	5.7
Latch Mounting Hardware	3.0

Table 3-6

SI Weight and C.G. Summary

SI	HRS	FOS	FOC	HSP	COSTAR	NICMOS	STIS	ACS	COS
Base Weight (lb.)	688.2	681.2	703.6	580.8	658	828.6	807	821	852
GFE Weight (lb.)	22.5	22.5	22.5	22.5	32.5	33	30	64	50.5
Total Weight (lb.)	710.7 (±1.1)	703.7 (±3.3)	726.1 (±1.1)	603.3 (±1.2)	690.5	861.6	837	885	902.5
A_1 (in.)	-36.53 (±.1)	-46.63 (±.28)	-42.33 (±.4)	-39.13 (±.25)	-43.29	-46.82	-42.7	-46.62	-20 to -50
A_2 (in.)	12.0 (±.1)	12.3 (±.28)	10.1 (±.4)	10.9 (±.25)	9.87	11.87	10.8	12.26	12 +/-1.7
A_3 (in.)	12.2 (±.1)	11.5 (±.28)	9.5 (±.4)	11.4 (±.25)	9.82	11.91	10.5	10.93	12 +/- 1.7

IRN 002, 004

3.5 ENVIRONMENTAL INTERFACES

3.5.1 Thermal Interfaces

The SIPE is intended to be used for transporting an SI into orbit for installation in the HST and returning the replaced instrument to Earth. The thermal environment inside the SIPE shall be maintained by passive and active means.

3.5.1.1 SI Temperature Limits. Table 3-7 defines the SI temperature limits for different mission phases. The replacement SI shall be maintained within the limits for cargo bay to Earth (-ZLV) attitudes; these limits condition the SI such that it can be installed into HST within the turn-on temperature range to allow for immediate SI turn-on and checkout. For other attitudes defined in ICD-A-14009-SM and for the returning SI, the SIPE shall maintain the non -ZLV limits. The SIPE shall maintain the returning SI between structural safety limits during all portions of the reentry and landing.

3.5.1.2 SI to SIPE Conduction Interfaces. The maximum effective thermal conductance of each latch point attachment fitting from the SIPE wall to the SI mounting surface shall be as follows: IRN 001

"A" Latch	.5 W/°C
"B" Latch	.5 W/°C
"C" Latch	.5 W/°C

IRN 001

Table 3-7

Axial SI Temperature Limits

	Lower Limit °C	Upper Limit °C
-ZLV Shuttle Attitude	+20	+30
Non -ZLV Shuttle Attitude	-10	+35
Structural Safety Limit	-55	+60

IRN 001

3.5.1.3 SI to SIPE Radiation Interfaces. For thermal design analysis purposes, the surface characteristics for the original and replacement SIs are identified in ST-ICD-02, paragraph 4.6.1.1.3.

3.5.2 Contamination

The ASIPE is considered contamination sensitive hardware per STR-29. This is, by definition, hardware that is taken inside the HST aft shroud or hardware that comes in contact with items inside the aft shroud. The design, assembly, and certification of the SIPE shall be performed in such a manner as to preclude the SIPE from being a contamination source to its payload.

Contamination requirements during STS descent/landing and post landing events will be limited by the capabilities of the filter specified in Section 3.3.7.

3.5.2.1 Cleanliness/Environment Requirements. The following requirements are based on the current Servicing Mission (SM) program plan. In the case where a conflict arises, the most stringent requirements shall apply.

a. Materials selected for HST spacecraft shall meet the minimum vacuum outgassing screening criteria as tested according to ASTM E-595 (i.e., have a maximum total mass loss [TML] of 1.0 percent and a maximum collected volatile condensible material [CVCM] of 0.10 percent). In general, a material is qualified on a product-by-product basis. However, GSFC may require lot testing of any material for which lot variation is suspected. This applies to high outgassing materials such as nonmetallics (i.e., paints, epoxies, etc.). In such cases, material approval is contingent upon the results of the lot testing. National Aeronautic and Space Administration (NASA) Reference Publication 1124 provides data on various spacecraft materials that were tested according to ASTM E-595. Even though a material meets the screening criteria, it may be inappropriate for use around or within sensitive hardware. This situation may arise as a result of the upper limits of the TML and CVCM being approached. For such cases, the amount of the material being used, the location of the material, and the deposition rate of the material in question shall be examined and approved by GSFC.

b. The contamination acceptance criteria are defined in Table 3-8. The field of view of the TQCM shall be filled as best possible by the hardware under test. To accurately determine the hardware outgassing rate, the TQCM shall be located in or as close to an enclosure opening as practical, thus isolating the chamber contributions to the TQCM.

c. The delivered SIPE shall have a minimum surface cleanliness level requirement of Visibly Clean Highly Sensitive (VCHS), Level B (Non-Volatile Residue) for exterior surfaces and 400 B for interior surfaces as specified in MIL-STD-1246.

d. The purge line shall be verified clean to Level 25 per MIL-STD-1246 and no greater than 1.0 mg/ft^2 (Level A) after an internal rinse. The hydrocarbon level shall be less than 1 ppm and moisture level shall be less than 1.5 ppm.

Table 3-8

Contamination Acceptance Criteria Test Summary

Test Parameter	Test Condition
Test Chamber Pressure	$<10^{-5}$ Torr
Hardware Temperature	10°C above the maximum on-orbit operating limits.
TQCM Crystal Temperature	10°C below the minimum on-orbit SIPE operating limit
Criteria Period	8 hours
Hardware Outgassing Rate	15 MHz crystal rate of 1 Hz/hr averaged over an 8 hour period

e. A minimum Class 100K environment per FED-STD-209, with a maximum of 15 ppm hydrocarbon content (expressed as methane equivalent) shall be maintained during final assembly and integration. A Class 10K environment shall be maintained during installation of an instrument into the SIPE.

3.5.2.2 Contamination Monitoring. Provisions shall be made for removable witness mirror(s) to be used for cleanliness monitoring.

3.5.3 Dew Point

During all ground, transportation, storage, pre-launch, and launch operations with the SI in place, the dew point of the air inside the SIPE shall be maintained by an externally supplied purge in accordance with the requirements of the SI.

Note that, during reentry, descent and landing the humidity of the air entering the SIPE is uncontrolled. All SI and SIPE surfaces which are at temperatures below the incoming air dew point are subject to condensation. After a normal landing, a cargo bay purge will be used to maintain the overall moisture level at less than 34 grains of water vapor per pound of air.

3.6 ELECTRICAL INTERFACES

3.6.1 SIPE/SI Interface

There shall be access to the SI for system checks via four external connectors located on the SIPE. Cabling may be routed from these connectors to the corresponding connectors which attach to the SI. The use of this interface is optional, depending on SI requirements. The wire shall be #16 AWG for the A and B power harnesses and #20 AWG, twisted shielded pairs, for the A and B signal command harnesses. The external connectors for these harnesses are specified in Tables 3-9a and b. The pin assignments are shown in Tables 3-10a through d. The external connectors shall be covered with flight compatible Electrostatic Discharge (ESD) caps when not in use.

3.6.2 Grounding

The SI frame shall be grounded to the ASIPE by means of a short, thin copper strap similar to that used between the Axial SIs and the HST. Using the same tools that are required to attach the HST ground strap to the Axial SI, it shall be possible to detach/reattach this strap from/to any axial instrument during ground or EVA instrument changeout. The resistance between the strap and the connecting structure at each end shall be no greater than 1.0 ohm. The SI end fitting is shown in Figure 3-12. Provision shall be made to stow the SI end of the ground strap when not attached to an SI.

Table 3-9a

SIPE/SI Harness Connectors

Conn.	Harness	External SIPE End
J5	A Power	LJTPQ00RT23-21P/453(-101)
J6	B Power	LJTPQ00RT23-21PA/453(-102)
J7	A Signal	LJTPQ00RT17-99P/453(-106)
J8	B Signal	LJTPQ00RT17-99PA/453(107)

Table 3-9b

SIPE/SI Harness Connectors

Harness	SI End
A Power	LJT06RT23-21S/453(-101)
B Power	LJT06RT23-21SA/453(-102)
A Signal	LJT06RT17-99S/453(-106)
B Signal	LGT06RT17-99SA/453(107)

Table 3-10a

SIPE/SI Pin Assignments

CONNECTOR J5 FUNCTION	A POWER PIN ASSIGNMENT
Power Bus	X
Power Return	W
Power Bus	V
Power Return	U
Power Bus	T
Power Return	S
Power Bus	R
Power Return	P
Remote Interface Unit Power Bus	N
Remote Interface Unit Return Bus	M
Remote Interface Unit Power Bus	L
Remote Interface Unit Return Bus	K
Spare	J
Spare	H
Spare	G
Spare	F
Spare	E
Spare	D
Spare	C
Spare	B
Spare	A

Table 3-10b

SIPE/SI Pin Assignments

CONNECTOR J6 FUNCTION	B POWER PIN ASSIGNMENT
Power Bus	X
Power Return	W
Power Bus	V
Power Return	U
Power Bus	T
Power Return	S
Power Bus	R
Power Return	P
Remote Interface Unit Power Bus	N
Remote Interface Unit Return Bus	M
Remote Interface Unit Power Bus	L
Remote Interface Unit Return Bus	K
Spare	J
Spare	H
Spare	G
Spare	F
Spare	E
Spare	D
Spare	C
Spare	B
Spare	A

Table 3-10c

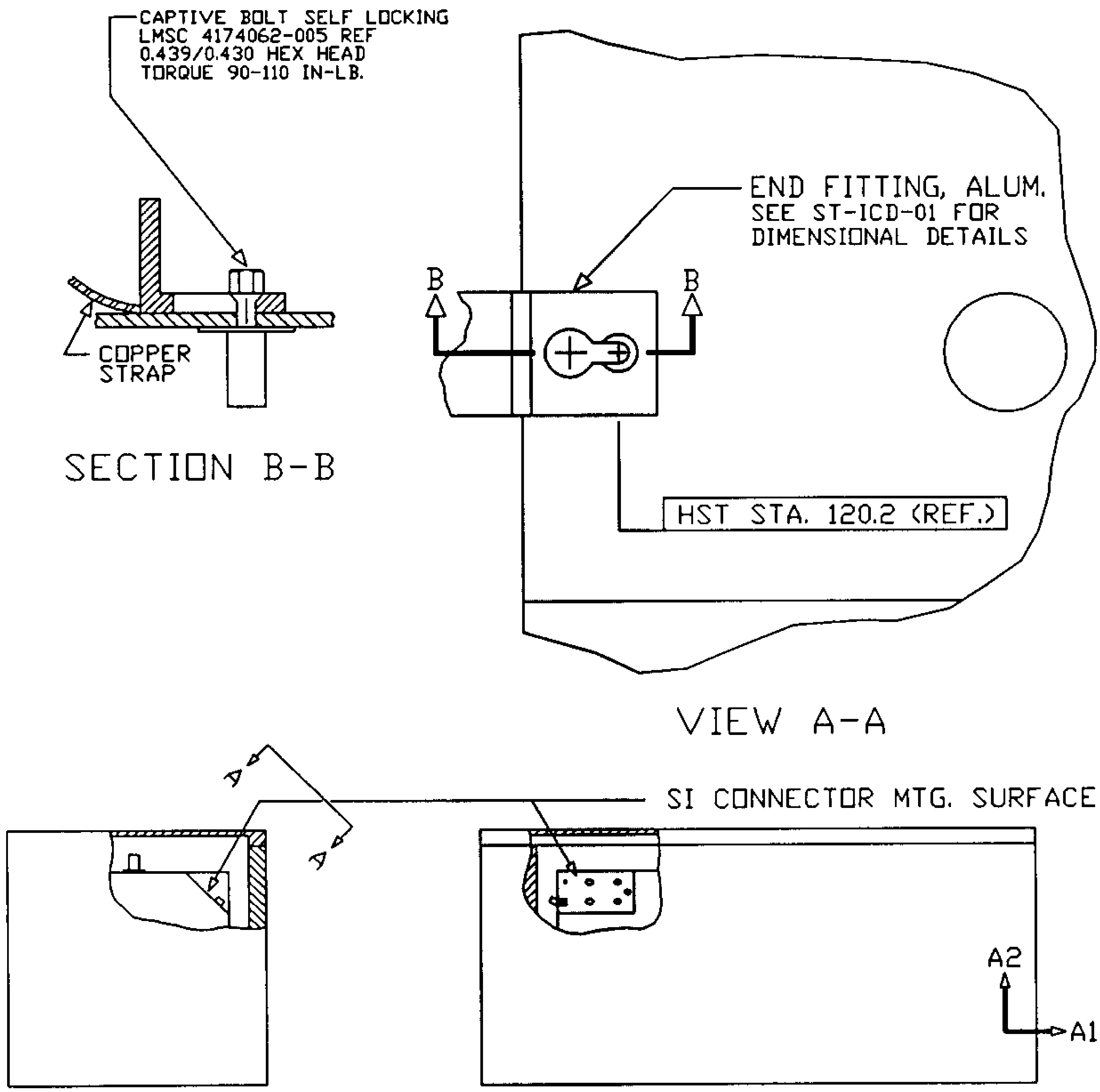
SIPE/SI Pin Assignments

CONNECTOR J7 FUNCTION	A SIGNAL COMMAND PIN ASSIGNMENT
Spare	Z
Science Data Ready True	Y
Science Data Ready Complement	X
Spare	W
Science Data Gate True	V
Science Data Gate Complement	U
Science Data Clock True	T
Science Data Clock Complement	S
Science Data True	R
Science Data Complement	P
Line Start True	N
Line Start Complement	M
Frame Start True	L
Frame Start Complement	K
Common Shield For SI Data Lines	J
Signal Ground	H
Supervisory Bus "A" True	G
Supervisory Bus "A" Complement	F
Supervisory Bus "A" Shield	E
Reply Bus "A" True	D
Reply Bus "A" Complement	C
Reply Bus "A" Shield	B
Spare	A

Table 3-10d

SIPE/SI Pin Assignments

CONNECTOR J8 FUNCTION	B SIGNAL COMMAND PIN ASSIGNMENT
Spare	Z
Science Data Ready True	Y
Science Data Ready Complement	X
Spare	W
Science Data Gate True	V
Science Data Gate Complement	U
Science Data Clock True	T
Science Data Clock Complement	S
Science Data True	R
Science Data Complement	P
Line Start True	N
Line Start Complement	M
Frame Start True	L
Frame Start Complement	K
Common Shield For SI Data Lines	J
Signal Ground	H
Supervisory Bus "B" True	G
Supervisory Bus "B" Complement	F
Supervisory Bus "B" Shield	E
Reply Bus "B" True	D
Reply Bus "B" Complement	C
Reply Bus "B" Shield	B
Spare	A



NOTE: References: ST-ICD-01, Figure 3.3.2-9 and ST-ICD-02, Figure 3.3-16.

Figure 3-12. **Ground Strap** Fitting, SI End

APPENDIX A

IRN 002

DEVIATION AND WAIVER APPENDIX

IRN 002

APPENDIX A
DEVIATIONS AND WAIVERS

A.1 INTRODUCTION/PURPOSE

The Orbital Replacement Unit Carrier (ORUC) and Second Axial Carrier (SAC) are relieved from the requirements of ST-ICD-91 to the extent shown on the NASA approved deviations and waivers listed below and included on the following pages.

REQUEST FOR DEVIATION/WAIVER (RFD/RFW)	1. DATE (YYMMDD) 96-12-30	Form Approved OMB No. 0704-0188

2. PROCURING ACTIVITY NUMBER

3. DODAAC

4. ORIGINATOR
a. TYPED NAME (First, Middle Initial, Last): Lawrence Slivinski
b. ADDRESS (Street, City, State, Zip Code): Goddard Space Flight Center, Code 442, Greenbelt, MD 20771

5. (X one): [ ] DEVIATION [X] WAIVER
6. (X one): [X] MAJOR [ ] MINOR [ ] CRITICAL

7. DESIGNATION FOR DEVIATION/WAIVER

a. MODEL/TYPE	b. CAGE CODE	c. SYS. DESIG.	d. DEV/WAIVER NO.
SM-2 ORUC	N/A	N/A	849-742-W005R1

8. BASELINE AFFECTED: [ ] FUNCTIONAL [ ] ALLOCATED [X] PRODUCT
9. OTHER SYSTEM/CONFIGURATION ITEMS AFFECTED: [ ] YES [X] NO

10. TITLE OF DEVIATION/WAIVER
Axial Science Instrument Loads Exceedences

11. CONTRACT NO. AND LINE ITEM
HB80E4921N, ORUC Deliverable Item 4.

12. PROCURING CONTRACTING OFFICER
a. NAME (First, Middle Initial, Last)
b. CODE
c. TELEPHONE NO.

13. CONFIGURATION ITEM NOMENCLATURE
SM-2 Orbital Replacement Unit Carrier

14. CLASSIFICATION OF DEFECT
a. CD NO.
b. DEFECT NO.
c. DEFECT CLASSIFICATION: [X] MINOR [ ] MAJOR [ ] CRITICAL

15. NAME OF LOWEST PART/ASSEMBLY AFFECTED
SM-2 Orbital Replacement Unit Carrier Assembly

16. PART NO. OR TYPE DESIGNATION
1558000

17. EFFECTIVITY
End Item ORUC for Servicing Mission 2

18. RECURRING DEVIATION/WAIVER: [ ] YES [X] NO

19. EFFECT ON COST/PRICE
None

20. EFFECT ON DELIVERY SCHEDULE
None

21. EFFECT ON INTEGRATED LOGISTICS SUPPORT, INTERFACE OR SOFTWARE
None

22. DESCRIPTION OF DEVIATION/WAIVER

ORUC system exceeds static structural load inputs to axial scientific instrument as specified in ICD ST-ICD-91 Paragraph 3.4.1.2. Rationale for acceptance is that ORUC loads are within axial scientific instrument design and test load capability as presented in Verification Loads Analysis LMMS/P460643. See attached excerpt.

23. NEED FOR DEVIATION/WAIVER

To authorize the use of ORUC as is for Hubble Space Telescope Servicing Mission 2.

24. CORRECTIVE ACTION TAKEN
None

25. SUBMITTING ACTIVITY

a. TYPED NAME (First, Middle Initial, Last)	b. TITLE	c. SIGNATURE
R. Hicks	PROGRAM MANAGER	12/30/96
L. Slivinski	COGNIZANT ENGINEER	12/30/96
O. Cheatom	QA	12-30-96
T. Bowser	C/DM	12/31/96

26. APPROVAL/DISAPPROVAL
a. RECOMMEND [ ] APPROVAL [ ] DISAPPROVAL

b. APPROVAL: [X] APPROVED [ ] DISAPPROVED
c. GOVERNMENT ACTIVITY: DPM FS&S PROJECT
d. TYPED NAME (First, Middle Initial, Last): George W. Morrow
e. SIGNATURE
f. DATE SIGNED (YYMMDD): 1/3/97

g. APPROVAL: [X] APPROVED [ ] DISAPPROVED
h. GOVERNMENT ACTIVITY: GODDARD SPACE FLIGHT CENTER
i. TYPED NAME (First, Middle Initial, Last): GIFFORD P. MOAK
j. SIGNATURE
g. DATE SIGNED (YYMMDD): 1/23/97

DD Form 1694, APR 92 CONTRACTING OFFICER Previous editions are obsolete

Figure A-1. LMMS CHAMP 849-742-W005R1
Axial Science Instrument Loads Exceedances (ORUC)

IRN 002

SPACE TELESCOPE IMAGING SPECTROGRAPH (STIS) STRENGTH ASSESSMENT (1 of 2)

LMMS/P460643

- Stress Report Reference: SAI-TM-668, "STIS Strength Assessment for VLC", By H. Atanasoff and A. Lieberman, dated 23 September 1996.
- STIS Strength memorandums furnished by Ball Aerospace were reviewed. All analyses show positive Margins of safety using design loads. Design load conditions and minimum Margins of Safety summarized below.

Component	Material	Stress (ksi)	Loading Condition	Factor of Safety	Margin of Safety
Enclosure Thermal Bracket	Graphite/Epoxy	34.59	Note (1)	1.40	0.00
K1B Mirror Flexures	Ti-6Al-4V	38.70	50 g	2.60	0.01
B-Fitting 8.1 pcf Honeycomb Core	Al5052	0.34	Note (1)	1.40	0.01
MSM Pin	A-286	74.87	19.7 g	1.25	0.02
Thermal Shelf	G-10	13.26	Note (1)	2.60	0.02
A Fitting 8.1 pcf Honeycomb Core	Al5052	0.34	Note (1)	1.40	0.03
CEB Fasteners	A-286	94.60	50 g	1.40	0.05
Thermal Shelf Bond	Epoxy	0.45	Note (1)	2.60	0.08
Optical Bench Aft X Fitting	Invar	29.20	Note (2)	1.00	0.09
B-fitting Panel Joint	Al6061-T6	25.90	Note (1)	1.40	0.16
A Fitting Panel Joint	Al6061-T6	25.90	Note (1)	1.40	0.16
Optical Bench Finger Joint bond	Epoxy	1.02	Note (2)	1.00	0.18
Oil Pan Bond	Epoxy	0.74	Note (1)	1.40	0.20
Enclosure X Fitting	Ti-6Al-4V	79.20	Note (2)	1.00	0.21
EG14/EG12 Frame Bar	Invar	16.23	50 g	2.00	0.23
K1B Frame	Al6061-T6	10.16	50 g	2.60	0.24
Enclosure X Fitting	Ti-6Al-4V	74.70	Note (2)	1.40	0.24
A Fitting 0.1 Facesheet	Ti-6Al-4V	74.00	Note (1)	1.40	0.26
MSM End Fitting	Invar 36	25.00	19.7 g	1.25	0.28
Enclosure, Inboar-Lower, Forward Blkd	A-286	108.50	Note (2)	1.00	0.29

Notes:
(1) Launch and Emergency Landing Loads (V1=±6.00 g, V2=±4.01 g, V3=±2.94 g) 850 lb preload at B fitting
(2) Sine Burst Test Loads (V1=±7.50 g, V2=±5.02 g, V3=±3.67 g) 850 lb preload at B fitting

Figure A-1. LMMS CHAMP 849-742-W005R1
Axial Science Instrument Loads Exceedances (ORUC) (continued)

SPACE TELESCOPE IMAGING SPECTROGRAPH (STIS) STRENGTH ASSESSMENT (2 of 2)

LMMS/P460643

Acceleration	VLC (g's)	Design (g's)	Test (g's)
Axial	5.10	6.00	7.50
Lateral	4.11	4.97	6.22
Root Sum Square	6.55	7.79	9.74

- **VLC Root Sum Square acceleration is enveloped by both the design and test loads**
- **Both the STIS optical bench and enclosure were strength qualified using Sine Burst testing. Test levels were based on 1.25 times the ILC loads.**
- **All components that did not meet the 1.25 test factor have been shown to have high Margins of Safety**

Figure A-1. LMMS CHAMP 849-742-W005R1
Axial Science Instrument Loads Exceedances (ORUC) (continued)

IRN
002

GODDARD HIGH RESOLUTION SPECTROGRAPH (GHRS) STRENGTH ASSESSMENT

LMMS/P460643

Minimum Margins of Safety for the High Resolution Spectrograph (HRS) SM2 ILC Loads					
Component	Stress/Load	Failure Mode	Material	Factor of Safety	Margin of Safety
A Fitting Screws	17.07 ksi	Tension	CRES 301	1.25	0.17
B Fitting Screws	554 lbs	Tension	CRES 301	1.25	0.19
Optical Bench Plate	11.73 ksi	Bending	Graphite/Epoxy	1.25	0.02
Cover Panel Rivets	102 lbs/in	Shear	A-286	1.40	1.07
Front/Aft Bulkhead Fitting	17.63 ksi	Combined	AL6061-T6	1.40	0.70

HRS ILC Loads	X=4.13 g's	Y=1.26 g's	Z=3.73 g's
HRS VLC Loads	X=3.36 g's	Y=1.13 g's	Z=3.42 g's

- Stress Report Reference: SAI-TM-669, "Strength and Fracture Assessment of FOS and HRS for SM #2 VLC Landing Loads", By H. Atanasoff, dated 22 September 1996.
- Margins re-calculated for ILC which were not enveloped by design stresses. Re-calculated margins shown above.
- VLC accelerations are less than ILC accelerations; therefore, ILC analysis still valid

Figure A-1. LMMS CHAMP 849-742-W005R1
Axial Science Instrument Loads Exceedances (ORUC) (continued)

IRN
002

REQUEST FOR DEVIATION/WAIVER (RFD/RFW)

1. DATE (YYMMDD): 96-12-30

Form Approved OM No. 0704-0188

2. PROCURING ACTIVITY NUMBER:

3. DODAAC:

4. ORIGINATOR
a. TYPED NAME (First, Middle Initial, Last): Lawrence Slivinski
b. ADDRESS (Street, City, State, Zip Code): Goddard Space Flight Center, Code 442, Greenbelt, MD 20771

5. (X one): [ ] DEVIATION [X] WAIVER

6. (X one): [ ] MINOR [X] MAJOR [ ] CRITICAL

7. DESIGNATION FOR DEVIATION/WAIVER
a. MODEL/TYPE: SM-2 ORUC
b. CAGE CODE: N/A
c. SYS. DESIG.: N/A
d. DEV/WAIVER NO.: 849-742-W006R1

8. BASELINE AFFECTED: [ ] FUNCTIONAL [ ] ALLOCATED [X] PRODUCT

9. OTHER SYSTEM/CONFIGURATION ITEMS AFFECTED: [ ] YES [X] NO

10. TITLE OF DEVIATION/WAIVER
Axial Science Instrument Loads Excedences

11. CONTRACT NO. AND LINE ITEM
H380E4921N, SAC Deliverable Item 1.

12. PROCURING CONTRACTING OFFICER
a. NAME (First, Middle Initial, Last):
b. CODE:
c. TELEPHONE NO.:

13. CONFIGURATION ITEM NOMENCLATURE
SM-2 Second Axial Carrier

14. CLASSIFICATION OF DEFECT
a. CD NO.:
b. DEFECT NO.:
c. DEFECT CLASSIFICATION: [X] MINOR [ ] MAJOR [ ] CRITICAL

15. NAME OF LOWEST PART/ASSEMBLY AFFECTED
SM-2 Assembly, Second Axial Carrier

16. PART NO. OR TYPE DESIGNATION
1545555

17. EFFECTIVITY
End Item SAC for Servicing Mission 2

18. RECURRING DEVIATION/WAIVER: [ ] YES [X] NO

19. EFFECT ON COST/PRICE: None

20. EFFECT ON DELIVERY SCHEDULE: None

21. EFFECT ON INTEGRATED LOGISTICS SUPPORT, INTERFACE OR SOFTWARE: None

22. DESCRIPTION OF DEVIATION/WAIVER
SAC system exceeds static structural load inputs to axial scientific instrument as specified in ICD ST-ICD-91 Paragraph 3.4.1.2 Rationale for acceptance is that SAC loads are within axial scientific instrument design and test load capability as presented in Verification Loads Analysis LMMS/P460643. See attached excerpt.

23. NEED FOR DEVIATION/WAIVER
To authorize the use of SAC as is for Hubble Space Telescope Servicing Mission 2.

24. CORRECTIVE ACTION TAKEN
None

25. SUBMITTING ACTIVITY

a. TYPED NAME (First, Middle Initial, Last)	b. TITLE	c. SIGNATURE
R. Hicks	PROGRAM MANAGER	12/30/96
L. Slivinski	COGNIZANT ENGINEER	12/30/96
H. Wallace	QA	12/31/96
T.A. Bowser	C/DM	12/31/96

26. APPROVAL/DISAPPROVAL
a. RECOMMEND [ ] APPROVAL [ ] DISAPPROVAL
b. APPROVAL: [X] APPROVED [ ] DISAPPROVED
c. GOVERNMENT ACTIVITY: DPM HST PROJECT
d. TYPED NAME (First, Middle Initial, Last): GEORGE W. MORROW
e. SIGNATURE:
f. DATE SIGNED (YYMMDD): 1/13/97
g. APPROVAL: [X] APPROVED [ ] DISAPPROVED
h. GOVERNMENT ACTIVITY: CONTRACTING OFFICER, HST PROJECT, GODDARD SPACE FLIGHT CENTER
i. TYPED NAME (First, Middle Initial, Last): GIFFORD P. MOAK
j. SIGNATURE:
k. DATE SIGNED (YYMMDD): 1/23/97

DD Form 1694, APR 92 — Previous editions are obsolete

Figure A-2. LMMS CHAMP 849-742-W006R1
Axial Science Instrument Loads Exceedances (SAC)

NEAR INFRA-RED CAMERA AND MULTI-OBJECT SPECTROMETER (NICMOS) STRENGTH ASSESSMENT (1 of 2)

LMMS/P460643

- Stress Report Reference: SAI-TM-666, "NICMOS Strength Assessment for VLC", By H. Atanasoff and A. Lieberman, dated 23 September 1996.
- **NICMOS Strength memorandums furnished by Ball Aerospace and Hercules were reviewed. All analyses show positive Margins of safety using design loads. Design load conditions and minimum Margins of Safety summarized below.**

Component	Material	Stress (ksi)	Loading Condition	Factor of Safety	Margin of Safety
Enclosure Honeycomb Inserts	Epoxy	1.15	Note (2)	2.60	0.00
Truss Joint Front Block	Epoxy	0.36	Note (1)	2.5 [5]	0.03
Enclosure Outboard PL Bolt	A-286	26.74	Note (2)	2.60	0.07
Enclosure Box Cover	AL6061-T6	14.99	Note (2)	2.60	0.08
Enclosure Forward Block Pl Bolt	A-286	53.24	Note (2)	2.60	0.08
Enclosure Aft Bulkhead Pl Bond	Epoxy	0.413	Note (2)	2.60	0.08
Enclosure Inboard Cover Bolt	A-286	45.43	Note (2)	2.60	0.09
Dewar Aft Cover Inner	AL6061-T651	38.62	Note (4)	1.00	0.09
Fore Optic Bracket Bond 2	Epoxy	0.24	Note (1)	3.5 [5,6]	0.11

Notes:

(1) Launch Loads (V1=± 6.00 g, V2= ± 2.94 g, V3=± 4.01 g) 850 lb pre-load at B fitting
(2) Launch and Emergency Landing Loads (V1=± 6.00 g, V2= ± 2.94 g, V3=± 4.01 g) 850 lb pre-load at B fitting
(3) Stresses are RSS combinations
(4) Launch loads from (2) are combined with an internal pressure load of 80 psi
(5) A basis allowables were used
(6) Factor of Safety = 3.50 = 1.40 x 2.50 (knockdown of epoxy allowables)

Figure A-2. LMMS CHAMP 849-742-W006R1
Axial Science Instrument Loads Exceedances (SAC) (continued)

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NEAR INFRA-RED CAMERA AND MULTI-OBJECT SPECTROMETER (NICMOS) STRENGTH ASSESSMENT (2 of 2)

LMMS/P460643

Acceleration	VLC (g's)	Design (g's)	Test (g's)
Axial	2.98	4.80	6.00
Lateral	4.12	3.48	4.97
Root Sum Square	5.08	5.93	7.79

- VLC Root Sum Square acceleration is enveloped by both the design and test loads
- Both the NICMOS optical bench and enclosure were strength qualified using Sine Burst testing
- All components that did not meet the 1.25 test factor have been shown to have high Margins of Safety

Figure A-2. LMMS CHAMP 849-742-W006R1
Axial Science Instrument Loads Exceedances (SAC) (continued)

FAINT OBJECT SPECTROGRAPH (FOS) STRENGTH ASSESSMENT

LMMS/P460643

Minimum Margins of Safety for the Faint Object Spectrograph (FOS) SM2 ILC Loads

Component	Stress/Load (ksi)	Failure Mode	Material	Factor of Safety	Margin of Safety
Bench Bulkhead	5.50	Combined	Al6061-T6	3.00	1.55
Cluster Fitting Weld	4.20	Tension	Al6061-T6	2.00	3.29
Cluster Fitting Weld	1.15	Shear	Al6061-T6	3.00	9.00
Gr/Ep Tube	2.60	Combined	Graphite/Epoxy	3.00	2.21
Invar Cluster Member	5.30	Combined	Invar	2.00	2.40
Truss Member Tubing	17.10	Buckling	Graphite/Epoxy	3.00	0.46
Truss Member Tubing	7.47	Bending	Graphite/Epoxy	3.00	0.12
Truss Member Tubing	6.95	Combined	Graphite/Epoxy	2.00	1.59
Invar Tube	14.20	Combined	Invar	2.00	0.27

FOS ILC Loads	X=1.29 g's	Y=1.32 g's	Z=4.90 g's
FOS VLC Loads	X=1.07 g's	Y=1.24 g's	Z=4.11 g's

- Stress Report Reference: SAI-TM-669, "Strength and Fracture Assessment of FOS and HRS for SM #2 VLC Landing Loads", By H. Atanasoff, dated 22 September 1996.
- Margins re-calculated for ILC which were not enveloped by design stresses. Re-calculated margins shown above.
- VLC accelerations are less than ILC accelerations; therefore, ILC analysis still valid.

Figure A-2. LMMS CHAMP 849-742-W006R1
Axial Science Instrument Loads Exceedances (SAC) (continued)

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